OPERATING INSTRUCTIONS

5775
U505

TYPE 1120-A, -AH

FREQUENCY STANDARDS

TYPE 1113-A STANDARD-FREQUENCY OSCILLATOR

TYPE 1114-A FREQUENCY DIVIDER

TYPE 1103-B SYNCRONOMETER

1120-A,-AH

GENERAL RADIO COMPANY

OPERATING INSTRUCTIONS

TYPE 1120-A, -AH

FREQUENCY STANDARDS

TYPE 1113-A STANDARD-FREQUENCY OSCILLATOR

5645

TYPE 1114-A FREQUENCY DIVIDER

TYPE 1103-B SYNCRONOMETER

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October, 1961

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West Concord, Massachusetts, USA

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

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TEST DATA
on
TYPE 1120-A_____ FREQUENCY STANDARD

Type 1103-B Syncronometer Serial No._____

Type 1114-A Divider Serial No. _____

Type 1113-A Oscillator Serial No. 178

Oscillator plate current 3.8 ma

Crystal unit Serial No. 2555

Operating temperature 76 C

Type 1112-A Multiplier Serial No. _____

Type 1112-B Multiplier Serial No. _____

Type 1116-A Emergency Power Supply Serial No._____

DATE: 4-25-62 OBSERVER: W. FISH

SPECIFICATIONS

TYPE 1113-A STANDARD-FREQUENCY OSCILLATOR

Frequency Stability:

Long-term: Less than 5×10^{-10} per day, averaged over 10 days, after 60 days of operation. After 1 year, typical drift is less than 2×10^{-10} per day.

Short-term: Less than 1×10^{-10} per minute, as measured with 1-second samples.

Vs Oven Cycling: Less than 1×10^{-10} peak-to-peak.

Vs Ambient Temperature: Less than 1×10^{-10}/°C (5×10^{-9} for 0-50 C).

Vs Line Voltage: Less than 1×10^{-10} for 105-130 volts.

Vs Loading: Less than $\pm 2 \times 10^{-10}$ for 50Ω ±20%.

Frequency Adjustment Range:

Coarse: Approx 500×10^{-9}.

Fine: $\pm 5 \times 10^{-9}$ in divisions of 5×10^{-10}. Can be set to within 1×10^{-10}

Outputs: 1 v rms into 50 Ω at 5 Mc. 0.4 v rms for Type 1112-A Frequency Multiplier.

Power Input: 105-125 (or 210-250) v, 50-60 cps. Power consumption is 100 watts maximum.

Tube Complement: One each 6AN8, 6AV5GA, 5965, 5727, 5651, 6922/E88CC; three 6688/E180F.

Transistor Complement: One each 2N1138, 2N1372; two 2N445A.

Dimensions: Width 19, height 5-1/4, depth behind panel 16 in. (485 by 135 by 410 mm).

Net Weight: 30 lb (13.6 kg).

TYPE 1114-A FREQUENCY DIVIDER

Input: 5 Mc, 1 Mc, 100 kc, 50 Ω. 1 v ±50%.

Output (with 5-Mc input):

Sine Waves: at 1 Mc and 100 kc, 1 v +50% −10% into 50 Ω; at 10 kc, 1 kc, and 100 cps, 1 v +50% −10% into 600 Ω; at 60 and 400 cps (with optional plug-in unit), 1 v +50% −10% into 600 Ω.

Square Waves: at 100 kc and 10 kc, approx 7 v peak-to-peak open-circuit.

Spurious Signals: Better than 34 db down.

Jitter: Less than 0.5 nsec for 100-cps output with 5-Mc input.

Power Input: 105-130 (or 210-260) v, 50-400 cps. Power consumption is approx 7 watts.

Transistor Complement: One each 2N645 and 2N1218, two 2N1396, three 2N1372, four 2N520, seven each 2N169A and 2N582, fourteen 2N404, sixteen 2N1374, and one 2N779A.

Dimensions: Width 19, height 5-1/4, depth behind panel 11 in. (485 by 135 by 275).

Net Weight: 17 lb (8 kg).

TYPE 1103-B SYNCRONOMETER

Input: 1000-cps sine wave, 1 v into 50 kilohms.

Microdial Contactor Stability: Maximum contact closing time deviation at any microdial setting is ±0.1 ~~μsec~~ millisec.

Calibration Errors: The maximum deviation between the indicated microdial setting and the actual contactor closing time varies sinusoidally from 0 to ±1 msec (maximum) over the 1000-msec range.

Accuracy of Time Increments: The maximum error over a time interval of ~~24~~ 25 msec is ±2% ±0.1 msec.

Power Input: 105-125 (or 210-250) v, 50-60 cps, 22 w continuous, 10 w addition for starting.

Dimensions: Width 19, height 8-3/4, depth behind panel 11 in. (485 by 225 by 280 mm).

Net Weight: 35 lb (16.0 kg).

General Radio Experimenter reference: Vol 35 No. 4, April 1961.

Type 1103-B
Syncronometer

Type 1114-A
Frequency Divider

Type 1113-A
Standard-Frequency Oscillator Divider

Type 1112-A
Frequency
Multiplier
1 - 10 - 100 Mc

Type 1112-B
Frequency
Multiplier
1000 Mc

Blank
Panels
to fill
Rack

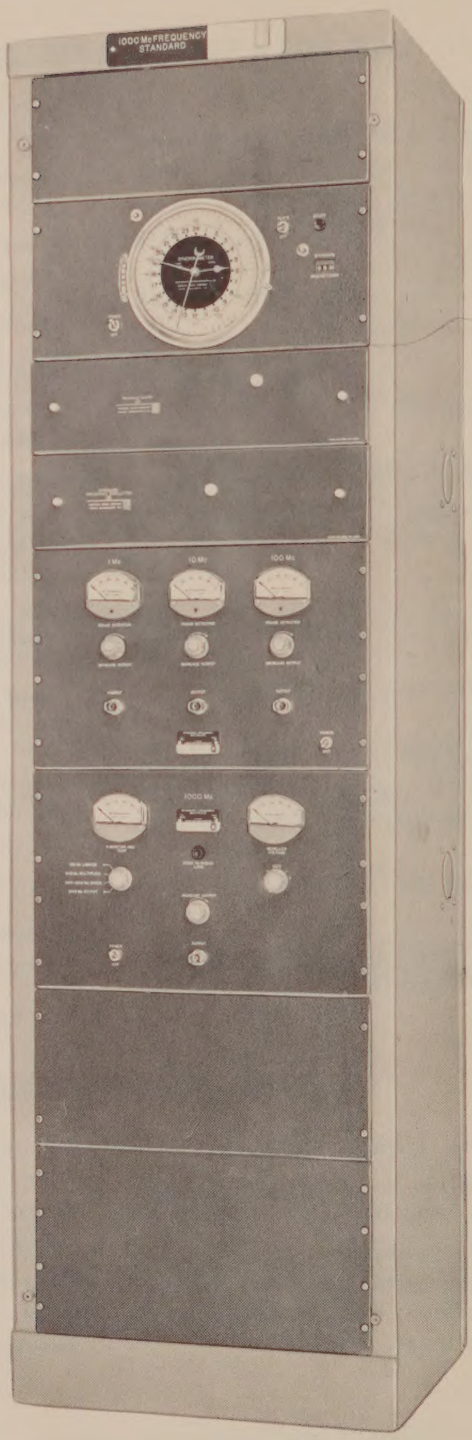


Figure 1. Type 1120-AH Frequency Standard (similar to Type 1120-A, except the latter does not include Type 1112 Standard Frequency Multipliers).

TYPE 1120-A
FREQUENCY STANDARDS

Section 1
PRINCIPLES OF FREQUENCY MEASUREMENT

1.1 FREQUENCY AND TIME. Frequency measurement is, by definition, based on time measurement; conversely, time measurement can be based on frequency measurement. The interrelation between frequency and time interval is so fundamental that a highly accurate and precise measurement of one is necessarily an equally accurate and precise measurement of the other. If 100 events, equally spaced in time, occur within, say, a minute, we know that (a) the frequency of occurrence is 100 per minute, and (b) the time interval between the beginning of one event and the beginning of the next is 1/100 minute, or 3/5 second. In this illustration, a succession of regularly occurring events was necessary. As a basis of time measurement, man has always sought the most dependably regular events available - historically, the movements of the stars and planets.

1.2 KINDS OF TIME. The basis of all time measurements, then, has long been astronomical observation. The lengths of the year and of the day, after certain corrections have been applied, are among our most reliable standards of time. The tropical year - that is, the time taken by the earth to orbit about the sun from vernal equinox to vernal equinox - is the basis of the time denoted as "Ephemeris Time", and the second has been defined as a very small fraction (1/31,556,925.975) of the tropical year 1900.

Our commonly used Universal Time - known also as Greenwich Mean Time - is based on the length of the "mean solar day". A solar day is the time taken by the earth to rotate once about its own axis with respect to the sun, assuming that the sun is a fixed reference point. Or, looking at it another way, a solar day is the time taken by the sun to make its apparent transit around the earth. Because the earth's equator is tilted with respect to its orbital plane, and because the earth's orbit is elliptical, the length of the solar day varies throughout the year. The average length of a solar day over the course of a year is called the "mean solar day"

Sidereal time is also based on the earth's rotation about its own axis, this time with respect to distant stars. Because of the great distances from the earth to these stars, rendering the stars virtually fixed reference points, the measurement of sidereal time can be carried out very precisely. Sidereal-time measurements are in fact used by astronomers in the calculation of solar time.

Ephemeris Time, based on the tropical year, and Universal Time, based on the mean solar day, can be intercompared by means of simultaneous observations of the moon and stars, and precise conversion of one to the other is possible.

1.3 THE SUBDIVISION OF TIME. Once the length of the day has been rigorously defined, it remains only to subdivide it into equal parts. A source of rapidly and regularly recurring events is needed for this purpose. The period of a pendulum can be made fairly constant, and pendulum clocks were long used as our most reliable timing devices. The period of even the best pendulum depends on the acceleration of gravity, and hence will show variations if the earth's gravity varies. The development of quartz-crystal oscillators for radio use in

the 1920's gave us our first time-frequency standards relatively independent of gravity. These oscillators, designed as stable frequency references, were also time-interval determinants of exceptional accuracy and stability.

1.4 THE QUARTZ CRYSTAL. Two outstanding qualities of crystalline quartz make it especially attractive as a control element for an oscillator: the possibility of obtaining resonators of high Q (frequency sensitivity), and the outstanding stability of the quartz itself over long periods of time. The variation of frequency of a quartz crystal resonator with temperature is a function of the shape of the crystal element, its dimensions, and its angle of cut from the mother crystal.

Quartz crystal resonators are produced in the form of bars, rings, and plates for various applications.

1.5 CRYSTAL OSCILLATORS. Crystal-oscillator circuits are designed for many purposes. Some produce relatively large amounts of power at the expense of considerable dissipation in the crystal element. Others yield little power but high frequency stability. The principal crystal-oscillator circuits used in frequency standards are known as (a) the Meacham bridge-stabilized oscillator[1], (b) the Gouriet-Clapp[2] or modified Pierce oscillator, and (c) the quartz servo-controlled oscillator[3]. The General Radio Type 1120 Frequency Standards use a form of the Gouriet - Clapp oscillator, described in paragraph 2.2.

1.6 STANDARD TIME TRANSMISSION. Every time/frequency standard must be checked periodically against a standard of higher accuracy, right up to the most accurate standards in the world, which are basically checked against astronomical observations. Checking one standard against another usually requires some sort of transmission of time-frequency information between the two standards. Appropriate governmental bureaus often assume the task of checking time directly against celestial movements, and of transmitting standard signals by radio. In the United States, the National Bureau of Standards operates radio station WWV, which transmits standard time signals on several radio frequencies, as does the U. S. Naval Observatory, over several stations of the Naval radio service. The power and frequencies of these signals are such that the time and frequency data measured at the U. S. Naval Observatory and at the Bureau of Standards are generally available over much of the world throughout the day. Other government agencies operate similar transmitters in England, Canada, Japan, Africa, Italy, and Belgium, and WWV has a Hawaiian auxiliary, WWVH. (Refer to paragraph 4.4.)

As a general policy, the Bureau of Standards' stations transmit both constant standard carrier frequencies and constant time intervals, while many of the other agencies transmit only standard time signals.

1.7 FREQUENCY DRIFT WITH TIME. For various reasons, crystal oscillators generally drift in frequency of oscillation as time elapses. The shape of this frequency-vs-time curve is usually exponential, with the frequency drifting rapidly at first and then at a decreasing rate. Crystal characteristics change slowly with time, and eventually reach a relatively low, constant drift rate. However, most quartz crystals continue to drift slowly indefinitely. Although this drift rate becomes approximately linear after several years, and can be considered as such without discernible error, the standard must be recalibrated frequently in order to insure output of the nominal standard frequency (refer to paragraph 4.4).

---

[1] L. A. Meacham, "The Bridge-Stabilized Oscillator", PROCEEDINGS OF THE IRE, Vol 26, pp 1278-1294; October, 1938.

[2] U. S. Patent Number 2,012,497

[3] N. Lea, "Quartz Resonator Servo - A New Frequency Standard", MARCONI REVIEW, Vol 17, pp 65-73, 3rd Quarter, 1954.

Section 2

GENERAL RADIO FREQUENCY STANDARDS

2.1 NOMENCLATURE. The General Radio Type 1120 Frequency Standard is available as either the Type 1120-A or the Type 1120-AH. The Type 1120-A comprises the following:

Type 1113-A Standard Frequency Oscillator
Type 1114-A Frequency Divider
Type 1103-B Syncronometer
Floor-Type Relay Rack and Cables

The Type 1120-AH 1000-Mc Standard comprises all of the above elements plus:

Type 1112-A Frequency Multiplier
Type 1112-B Frequency Multiplier.

2.2 TYPE 1113-A STANDARD-FREQUENCY OSCILLATOR. The Type 1113-A Standard-Frequency Oscillator contains a crystal oscillator, amplifiers, temperature control circuits, and power supplies for line operation. As shown in the block diagram (Figure 2), the output from the crystal oscillator is amplified by two tuned amplifiers, then rectified and returned as an AGC voltage to the grid of the oscillator tube. This keeps the rf level at the grid below 10 mv and the dissipation in the crystal very low.

Figure 3 shows details of the oscillator circuit. The crystal unit X601 operates in the fifth overtone mode. In order to ensure that it cannot oscillate in the third overtone mode (about 3 Mc), the combination of C604 and and L602 is inductive below about 3.7 Mc. At the proper operating frequency (5 Mc), this LC combination is capacitive to provide positive feedback. The inductor L601 is needed for initial frequency adjustment, and its value must be determined for each crystal unit. C602 is the COARSE FREQ control. Its range is about 500 x 10^{-9}. C246 is the FINE FREQ control, with a range of about 10 x 10^{-9} to permit setting to 1 x 10^{-10}. The diode CR201 protects the crystal from transients when the oscillator starts.

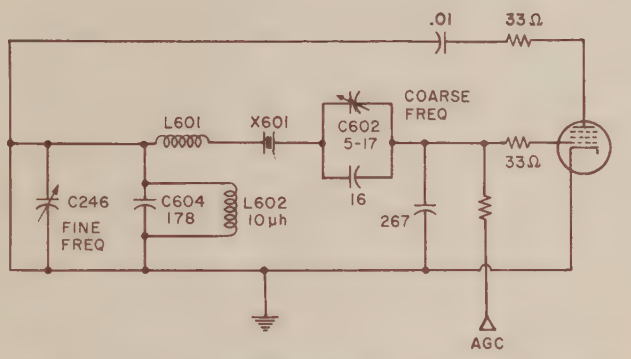


Figure 3. Type 1113-A Oscillator Circuit. Capacitance values less than 1 are in μf, over 1 in pf.

The crystal oscillator is followed by two tuned amplifiers and a cathode follower (see Figure 2). Rf feedback stabilizes the gain. The cathode follower drives the AGC rectifier. A positive delay bias is used to stabilize the crystal drive level against changes of transconductance of the oscillator tube.

The output amplifier provides additional isolation and gain. The output level can be varied over a 2:1 range by adjustment of rf feedback in this stage. This gain control affects the output impedance slightly.

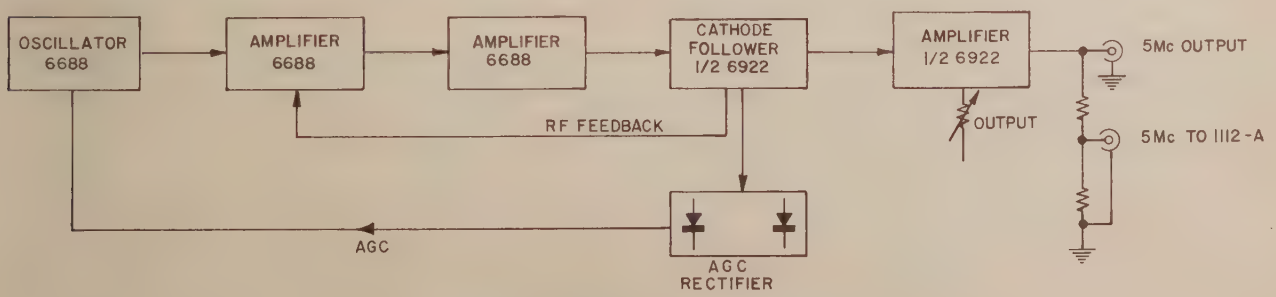


Figure 2. Type 1113-A Block Diagram.

The crystal and associated components are housed in a two-stage oven. The inner stage uses a mercury thermostat, which operates a thyratron as an electronic relay. A bimetallic thermostat controls the power of the outer stage.

The power supply operates from 105-130 (or 210 - 260) volts, 50-60 cps. Oscillator plate and heater supplies are regulated. A transistorized low-voltage regulator supplies dc for the heaters. A fan cools the cabinet to permit operating at ambient temperatures up to 50 C. The fan's precision bearings are hermetically sealed and lubricated for life.

A five-point meter circuit permits monitoring of the unit during operation. The five switch positions are:

AGC, in which the meter measures the dc grid voltage of the oscillator tube (5 volts full scale);

OUTPUT, in which the meter indicates rf output (5 volts full scale);

OSC PLATE, in which the meter indicates plate current of the oscillator tube (5 ma full scale);

INNER OVEN TEMP, in which the meter indicates the temperature of the inner oven. Full scale is about ±3 C from nominal. Normal indication is center of scale;

OUTER OVEN TEMP, in which the meter indicates the temperature of the outer oven. Full scale is about 100 C, normal indication about 28 μa.

2.3 TYPE 1114-A FREQUENCY DIVIDER. The Type 1114-A Frequency Divider converts a 5-Mc input signal into fundamental frequencies of 1 Mc, 100 kc, 10 kc, 1 kc, and 100 cps. Optional plug-in units for 400 cps and 60 cps are available. The Divider will operate with input frequencies of 1 Mc or 100 kc.

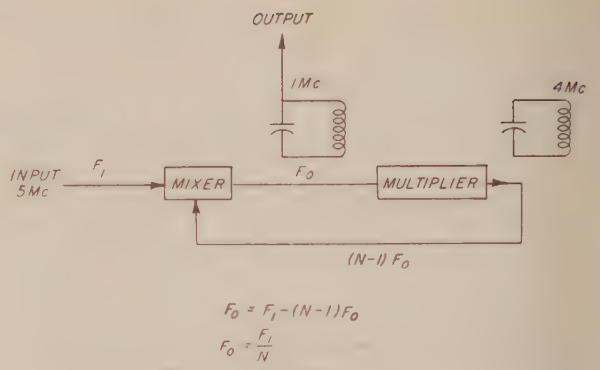


Figure 5. Block Diagram of Regenerative Divider.

Figure 4 is a block diagram of the unit. The first stage is a regenerate divider from 5 to 1 Mc. Its sine-wave output is formed into pulses to drive the lower-frequency switching-type dividers. If 1-Mc or 100-kc input is used, the pulses are generated at the input frequency. The divider is completely monostable. There is no output when the driving signal is absent. All output frequencies are available as sine waves. In addition, there are square-wave outputs at 100 kc and 10 kc.

Figure 5 is a block diagram of the regenerate divider. Its operation may be described as follows: A small amount of noise at 1 Mc produces a small 4-Mc signal, which is then mixed with the 5-Mc input to increase the 1-Mc output. This action is regenerative and may be compared to the starting of an oscillator.

Figure 6 shows a typical "switching" divider for the lower frequencies. The square-wave input is formed

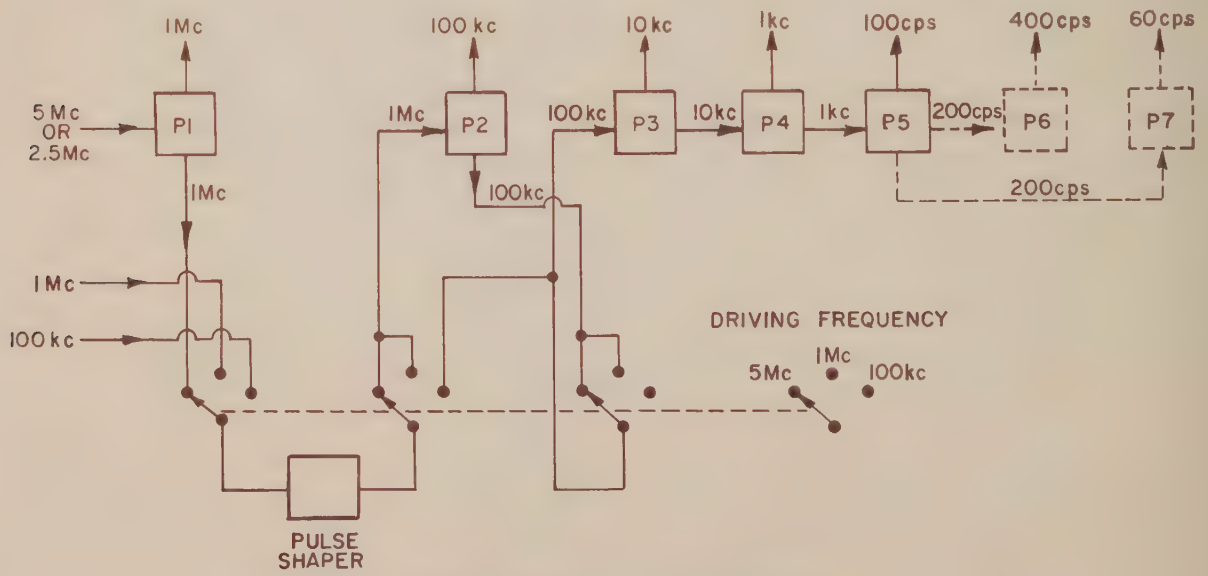


Figure 4. Type 1114-A Block Diagram.

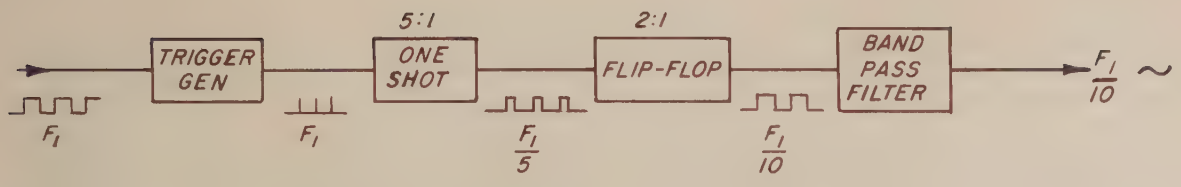


Figure 6. Typical Switching Divider for Lower Frequencies.

into a short trigger which drives a monostable multivibrator (one-shot), set so that it is reset by every fifth trigger. This stage is followed by a bistable multivibrator (flip-flop), which divides by two. The output is a square wave of one-tenth the input frequency. A bandpass filter selects the fundamental frequency of this square wave to provide sine-wave output.

The 400-cps unit (optional) selects the second harmonic of a 200-cps signal, obtained from the multivibrator in the 1-kc-to-100-cps divider.

The 60-cps unit (optional) divides the same 200 cps by 10, and the filter selects the third harmonic of the 20-cps square wave.

All units are powered by a single power supply of -18 volts (positive side grounded). A high-gain series regulator reduces hum and permits unregulated dc input of -20 to -30 volts. The built-in rectifier operates from 100 to 130 (or 200 to 260) volts, 50 to 400 cps.

In cases where direct battery operation is desired, a 20- to 30-v battery may be connected to the regulator input, provided its positive side can be grounded. The total drain will be less than 200 ma (5 w at 24 v).

2.4 SYNCRONOMETER. The Type 1103-B Syncronometer, supplied with the Type 1120-A Standard, comprises a 1-kc synchronous motor and clock to display the integral of the number of cycles executed by the standard-frequency oscillator as a standard time interval. By means of the microdial, the "second" as indicated by the synchronous motor driven by the standard can be compared with the standard second as received from standard time radio transmissions (e.g., from WWV). A contactor in the microdial opens for about 0.05 second, once each second (i.e., once each 10 revolutions of the synchronous motor). The time of closing can be adjusted with respect to the incoming time signals so that, for instance, only the start of each time signal is heard. The amount of adjustment necessary to achieve synchronism is indicated on the calibrated microdial; in this manner the performance of the frequency standard can be checked against standard time, offering a means of calibration accurate to ±1 part in 10^9 over a 48-hour period. When the Syncronometer is used with the Type 1109-B Comparison Oscilloscope, time comparisons can be made to ±0.1 millisecond or one part in 10^9 for 24 hours. Variations in radio propagation may reduce the over-all accuracy of this time-interval comparison by approximately 2:1.

2.5 TYPES 1112-A AND 1112-B STANDARD FREQUENCY MULTIPLIERS. The Types 1120-AH Frequency Standard includes the Types 1112-A and -B Standard Frequency Multipliers. The Type 1112-A, when driven by a special 5-Mc output from the Type 1113-A, provides four outputs: one each of 1 Mc and 10 Mc, and two of 100 Mc. The Type 1112-B multiplies the 100 Mc output of the Type 1112-A to provide a 100-Mc signal.

For full information on the Standard Frequency Multipliers, refer to the Type 1112-A/B Operating Instructions.

Section 3
INSTALLATION

3.1 MOUNTING. The components of the Type 1120-A or -AH Frequency Standard are shipped already mounted in a standard relay rack, complete with blank panels to fill the available rack space of 70 inches. All internal wiring is complete, and the only connection required is to the power line. Before connecting power, check the nameplate adjacent to the power cord to determine the line voltage for which the equipment is wired. Units are normally shipped wired for 115-volt service, but can be rewired for 230-volt use (refer to Section 5).

The motor of the Type 1103-B Syncronometer is shock-mounted. In shipment the mountings are clamped by two 1-1/2-inch 10-32 screws. These screws, on the bottom of the Syncronometer and identified by large washers, should be removed before operation. The clamping screws must be reinstalled every time the equipment is to be shipped.

If the Type 1113-A Standard-Frequency Oscillator is purchased separately and is to be rack mounted, be sure to install the triangular supports supplied with the instrument. The Type 1113-A must not be supported by its flanges.

3.2 USE OF DIVIDER WITH OTHER OSCILLATORS. The Type 1114-A Frequency Divider can be driven by any oscillator capable of supplying 1 volt rms into 50 ohms at 5 Mc, 1 Mc, or 100 kc. At 5 Mc, the input should be sinusoidal; at 1 Mc and 100 kc, square waves and pulses can be used. The input voltage requirement for nonsinusoidal waveforms is from 1.5 to 5 volts peak-to-peak. With nonsinusoidal waveforms, it is important that the pulse shaper be adjusted as described in paragraph 5.3.2.

The DRIVING FREQ switch on the front panel of the Type 1114-A should be set to the appropriate position, and the signal applied to the appropriate input connector (5 Mc, 1 M, or 100 kc).

Section 4
OPERATING PROCEDURE

4.1 PLACING THE STANDARD IN OPERATION. Set the power switch on the Type 1113-A Standard-Frequency Oscillator to STANDBY and the meter switch to OSC PLATE. Then connect the power cord to a 115- or 230-volt line, as indicated on the nameplate adjacent to the cord. After a warmup period of six hours or longer, set the power switch on the Type 1113-A Standard-Frequency Oscillator to ON. Watch the meter; it should start slowly from zero, swing beyond full scale, and then drop back. Compare the meter readings in all positions of the meter switch with the table on the rear of the front panel.

4.2 STARTING AND SETTING SYNCRONOMETER. To start the Syncronometer motor, press the start button on the panel of the Type 1103-B Syncronometer and momentarily throw the PLATE switch to OFF until the motor starts. Then leave the PLATE switch ON. When the Syncronometer motor comes up almost to synchronous speed, give the start button successive short pushes to bring the motor into synchronism. When starting the motor, open the door covering the clock face in order to hear the beating of the motor with the 1000-cycle driving signal. When the motor "locks in", the tone will become stable.

To set the Syncronometer, insert the crank into the opening at the upper left of the clock face. Each "turn" advances or retards the second hand by 15 seconds. If it is necessary to reset by a considerable amount, open the door and manually advance or retard the clock hands. When the adjustment is finished, be sure that the minute and sweep second hands are synchronized. Make the final fine setting with the crank. The crank adjustment sets the second, minute, and hour hands.

4.3 USE OF THE MICRODIAL FOR TIME CHECKS. Several agencies throughout the world operate standard frequency and time radio stations whose signals can be

used to check the frequency standard. The principal stations in North America are WWV (Washington, D.C.), NSS (Annapolis, Md), NBA (Balboa, Canal Zone), and CHU (Ottawa, Ont). Time signals from WWV are usually available in North America on at least one of the six standard frequencies used. For more information on transmitted time signals, write to the National Bureau of Standards, Boulder, Colo.; the U.S. Naval Observatory, Washington 25, D.C.; or the Dominion Observatory, Ottawa, Ont.

Time signals are broadcast from observatories or standards laboratories at one-pulse-per-second intervals. Such signals can be used to calibrate the frequency of an oscillator, if the oscillator frequency is divided, by electrical or mechanical means, down to a frequency of one event per second. The time of occurrence of the locally generated pulse is set to coincide with the time of reception of the standard time signal. After one day of operation, the relative time of occurrence of the local pulse is compared with the time of reception of the standard time signal. Suppose that the start of the local pulse is found to occur 86.4 milliseconds before the start of the time signal (after one day of elapsed time). Since there are 86.4×10^7 milliseconds per day, the oscillation is

$$\frac{86.4}{8.64 \times 10^7} = 1 \times 10^{-6}$$

high, or 1 part per million above its nominal value. The frequency is too high because the oscillator completed its quota of oscillations in a shorter time than it should have. Or, stated another way, the oscillator exceeded the nominal number of oscillations each second by the amount derived from the calibration, $+1 \times 10^{-6}$.

The microdial on the Syncronometer allows the user to check time as a function of the oscillator frequency against time as received from a source such as WWV. To make such a comparison, first connect the microdial contactor leads (the cable marked A4, at the rear of the Syncronometer) across the audio-frequency output of a communications receiver. Then tune the receiver to the time-signal frequency. The microdial contactor opens for only 0.05 second each second, and at all other times the receiver output will be shorted, and the time signals muted. The time of opening can be brought into coincidence with the very beginning of each time tick by means of the crank adjustment adjacent to the microdial scale. For a time diagram of this operation, see Figure 7. Turn the crank so that the microdial setting decreases, until the sound of the time tick is audible only as a very short click.

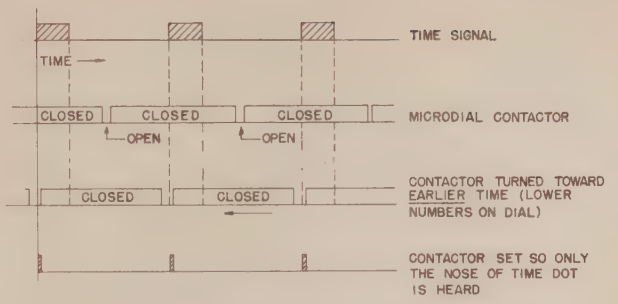
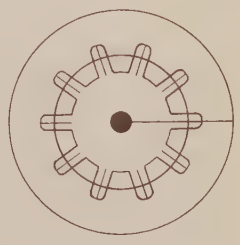


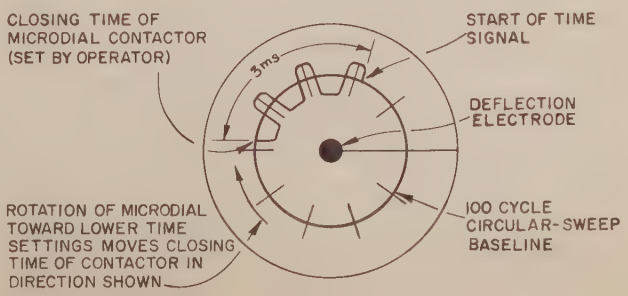
Figure 7.
Diagram of Time Comparison Using the Microdial.

A more precise and more reliable check of frequency against time signals is afforded by use of the Type 1109-A Comparison Oscilloscope, a component of the Type 1105-A Frequency Measuring System. This system, which uses a visual display of the time signals on the circular-sweep oscilloscope, is described in the *General Radio Experimenter* for June, 1958, and details are available on request. The use of this oscilloscope provides an accurate time-of-arrival indicator driven directly by the standard oscillator and independent of variations in the microdial contactor. The display should appear as shown in Figure 8.

The user who lacks the Type 1105-A Frequency Measuring System can nevertheless use an oscilloscopic display. A trigger pulse may be derived as shown in Figure 9. A 22½-volt battery in series with a 100,000-ohm, ½-watt resistor should be connected across the oscilloscope sweep trigger terminals, with a 1000-ohm resistor in series with the microdial terminals. The terminals of the microdial are closed for about 0.95 second and open for about 0.05 second (these figures are representative only; the actual length of the "open" period may

Figure 8.
(right) Time Signals as Received from CHU. (below) Display with Microdial Set to Close 3 Milliseconds after Start of Time Signal.




CLOSING TIME OF MICRODIAL CONTACTOR (SET BY OPERATOR)
3ms
START OF TIME SIGNAL
DEFLECTION ELECTRODE
ROTATION OF MICRODIAL TOWARD LOWER TIME SETTINGS MOVES CLOSING TIME OF CONTACTOR IN DIRECTION SHOWN
100 CYCLE CIRCULAR-SWEEP BASELINE

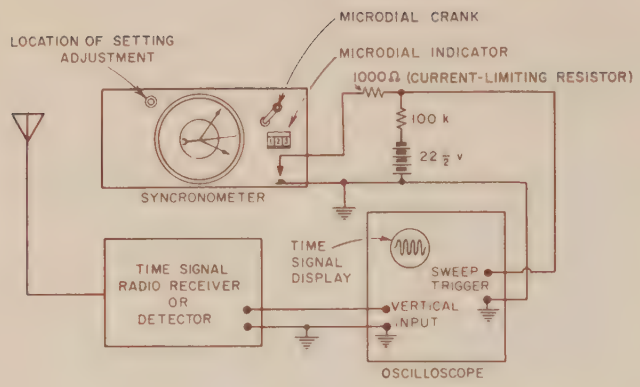


Figure 9. Setup for Time Checks Using Microdial

vary 2:1 from this value). The battery-resistor combination used with the microdial contactor provides a pulse suitable for triggering an oscilloscope with an externally controlled sweep circuit. The time signal from the output of the radio receiver or detector is applied to the vertical deflection terminals of the oscilloscope. A preliminary check on time of arrival of the time signal can be made with a sweep duration slightly longer than one second (total) in order to estimate the delay of the time signal relative to the setting of the microdial contactor which initiates the sweep. The microdial should then be adjusted to bring the time signal near the starting time of the sweep. Then the sweep duration should be decreased to increase resolution. The time of arrival of the time signal may then be logged from the microdial setting (see Figure 9). If the same time delay is allowed at all times between the starting time of the sweep (as determined by the microdial setting) and the start of the time signal (as displayed on the oscilloscope), then the difference between microdial time readings over a given time interval will be an accurate measure of time gained or lost on the Syncronometer.

Once the microdial is synchronized with the time signals, any subsequent deviation is represented by the number of milliseconds the dial must be readjusted to restore synchronization. The microdial is direct reading in milliseconds, and each millisecond is divided into 0.2-millisecond graduations. For instance, if the initial microdial setting is 250.0 milliseconds and 24 hours later it must be reset to 249.0 to synchronize with the time signal, the change in indicated time (Δt) is -1.0 millisecond or -0.001 second. Since there are 86,400 seconds in a day, this 0.001-second change represents a time gain of $\frac{0.001}{86{,}400}$ or 1.16×10^{-8}. Since the clock lost time, the frequency standard was low in frequency.

The following table will be found useful in correlating microdial readings with parts per 100 million (based on a 24-hour time interval):

PARTS IN 10^8	MILLISECONDS PER DAY
0.5	0.43
1	0.86
1.5	1.30
2	1.73
2.5	2.16
3	2.59

Since one can easily read half divisions (0.1 millisecond) on the microdial scale, comparisions can be made to better than ± 1 part in 10^{-9}. The ultimate accuracy of the time-signal transmissions can be realized only by the use of an oscilloscope. Ultimately, small variations in the contactor closing time (less than ± 0.1 millisecond) and variations in propagation time of the time signals limit the over-all accuracy to about $\pm 2 \times 10^{-9}$ in 24 hours.

It should be noted that high-frequency (3 to 30 Mc) radio time signals arriving by sky-wave paths are subject to appreciable variations in propagation time, even over relatively short time intervals. Consequently, it is not advisable to use short-time measurements of arrival time of high-frequency signals in frequency calibrations. Measurements made over an interval of 24 hours or longer are recommended for such use.

4.4 LOGGING PERFORMANCE. A good log is indispensable to the user who desires a continuous check on the accuracy of his frequency standard. Such a log may be a running account of frequency comparisons (refer to paragraph 4.5) or a chronicle of daily microdial resettings.

Time signals are generally available from WWV throughout the United States; however, for maximum reliability, it is recommended that the microdial be checked daily against as many time-signal stations as can ordinarily be received. The primary frequency standard at General Radio is checked daily against WWV, CHU, and NSS.

In this way, not only will checks be less dependent on vagaries of radio transmission paths, but a correction applied at one of the standard transmitters will be recognized as such and not misinterpreted as instability in the Type 1120-A.

It should be noted that a fixed day-to-day microdial adjustment indicates that the frequency standard is high or low in frequency – but not that the standard is drifting. If microdial settings for successive days are 50.0, 49.9, 49.8, 49.7, etc., there is a constant error of one-tenth division, or 0.1 millisecond per day. Thus the frequency error is about -1 part in 10^9, but the standard is not drifting in frequency. It is merely set low in frequency and can be corrected by adjustment of C246 by the necessary amount. It is important to remember that, even if the frequency remains rock-steady, there will be

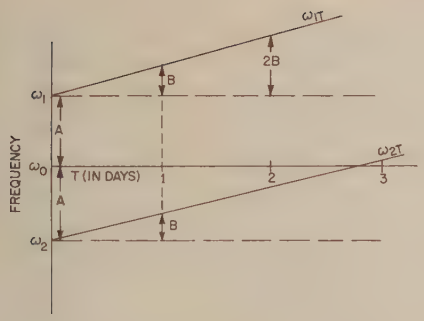


Figure 10a Effects of Constant Oscillator Drift.

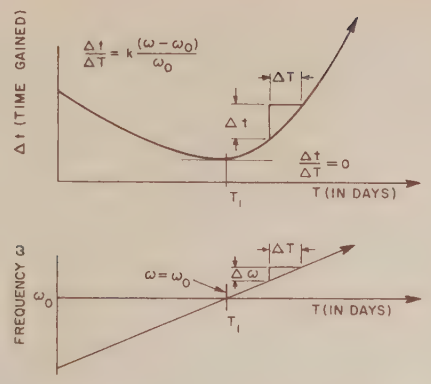


Figure 10b Plot of Time Gained (Δt) vs T (Days) Compared with Frequency (ω) vs T (Days) for Same Oscillator.

a constantly increasing time deviation as long as the frequency is the slightest bit high or low.

The relationship between time gained or lost and frequency change as a function of elapsed time is shown in Figure 10. Figure 10a shows the effects of a constant oscillator frequency drift rate on the frequency of the standard oscillator. Figure 10b shows the parabolic shape of the Δt (time gained or lost) curve and its relation to the oscillator frequency. (Not all oscillators exhibit linear frequency change vs time, but this characteristic is that most often observed in good frequency standards after an initial stabilization period.)

In Figure 10a, ω_o is the nominal oscillator frequency, ω_1 is a frequency setting initially high by an amount A (i.e. A is positive), and ω_2 is a setting initially low by an amount A (A is negative). B is the amount the frequency has drifted after one day. After two days, the total drift is 2B, etc. The frequency error, ω_T, may be expressed as:

$$\omega_T = 2\pi f = A + BT$$

where: A = ω_1, or ω_2 = initial setting of oscillator frequency

B = change in frequency per day

T = time in days

In Figure 10b, the time gained, Δt, is plotted against T, elapsed time in days. The change in the Δt curve for a time increment ΔT gives the slope, $\frac{\Delta t}{\Delta T}$, of the Δt curve. This slope is proportional to the difference between the nominal correct frequency, ω_o, and the actual frequency, ω. If this frequency difference is divided by ω_o and multiplied by the proper value, k, it can be expressed as a frequency deviation in parts per 10^8, or as any other convenient ratio. Thus $\frac{\Delta t}{\Delta T} = \frac{k\,(\omega - \omega_o)}{\omega_o}$. Note that as ω departs farther from ω_o, $\frac{\Delta t}{\Delta T}$ becomes larger. Thus, although $\frac{\Delta \omega}{\Delta T}$ is constant, $\frac{\Delta t}{\Delta T}$ increases as the square of the elapsed time, T.

A suggested log form for daily microdial checks is shown in Figure 11.

FREQUENCY-STANDARD LOG

DATE	TIME (EST)	MICRODIAL READINGS WWV	Δt(ms/day)	NSS	Δt(ms/day)	CHU	Δt(ms/day)	REMARKS
8/14/59	0900	5 Mc 49.7		9425 kc 50.1		7335 kc 49.6		Fading on all signals
8/15	0900	49.9	+0.2	50.1	0	49.7	+0.1	
8/16	0900	50.1	+0.2	50.3	+0.2	49.9	+0.2	
	1300	50.2	(+0.1)	missed		50.1	(+0.2)	Propagation (daily change)
	1500	50.2-	(−0.05?)			50.0	(−0.1)	
8/17	0900	50.3+	+0.2+	50.5+	+0.2(+)	50.1	+0.2	Reset FINE FREQ adj -1.5×10^{-9} (from +3.0 to +1.5)
	0905							

Figure 11. Suggested Microdial Log Form.

4.5 FREQUENCY COMPARISONS. The frequency of the Type 1120 can be checked against the frequency of a standard radio transmission by a simple system of beating one against the other. Because of the presence of interfering signals, fading, or other difficulties in reception of the transmitted frequency, comparison against time is usually a more convenient and reliable method of checking the standard.

The standard frequencies supplied by the Type 1120, with Type 1108-B Coupling Panel added, coincide with those transmitted by the U.S. Bureau of Standards' Station WWV. If a communications receiver is tuned to a frequency on which both WWV and the Type 1120 harmonics are audible, any slight difference in the two frequencies will produce a "beat", a periodic waxing and waning in intensity. The rate of this waxing and waning is the difference in frequency, which can be counted against a stop watch or against the sweep second hand of the Type 1103-B Syncronometer.

Frequency comparisons with very-low-frequency standard broadcasts are probably the most precise means of calibrating local frequency standards. Frequency calibrations to an accuracy of $\pm 1 \times 10^{-9}$ can be made with averaging times of less than 10 minutes, and an accuracy of $\pm 1 \times 10^{-10}$ can be achieved over 30 minutes with proper equipment. For a discussion of the methods and procedures used in vlf calibration, refer to "Intercontinental Frequency Comparison by Very Low Frequency Radio Transmission," by John A. Pierce, *Proc IRE*, Vol 45 No. 6, June 1957, pp 794-803. Most precise calibration requires the use of synchronous detection systems with very narrow effective bandwidth achieved by servo-control techniques.

4.6 FREQUENCY ADJUSTMENTS OF THE OSCILLATOR. After the frequency standard has been found high or low by either time or frequency comparison, it is possible to correct the frequency of the oscillator to compensate for the error. There are two frequency adjustments, one coarse (FREQ COARSE) and one fine (FREQ FINE). The coarse adjustment has a range of about 500×10^{-9}. The dial is calibrated for logging purposes only; the frequency is not a linear function of dial reading. The fine frequency adjustment has a total range of about 10×10^{-9}, and is calibrated in divisions of 5×10^{-10}.

4.7 FREQUENCY MEASURING EQUIPMENT. The General Radio Type 1105-B Frequency Measuring Equipment contains all the auxiliary equipment necessary for the accurate measurement of unknown frequencies in terms of standard frequencies from the Type 1120. The Type 1105 contains the following instruments, each available separately as well as part of the assembly:

Type 1106-A, -B, -C Frequency Transfer Units
Type 1107-A Interpolation Oscillator
Type 1108-B Coupling Panel, including harmonic generator
Type 1109-B Comparison Oscilloscope
Type 480-MA Relay Rack

Full descriptions of this equipment are given in the current General Radio Catalog.

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Section 5

SERVICE AND MAINTENANCE

5.1 GENERAL. The two-year warranty given with every General Radio instrument attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible.

In case of difficulties that cannot be eliminated by the use of these service instructions, please write or phone our Service Department, giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office (see back cover), requesting a Returned Material Tag. Use of this tag will insure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.2 TYPE 1113-A STANDARD-FREQUENCY OSCILLATOR.

5.2.1 FREQUENCY ADJUSTMENT. Refer to paragraph 4.6.

5.2.2 ALIGNMENT OF AGC AND OUTPUT AMPLIFIER. Do not attempt to tune the inductors on the amplifier board without following the specified procedure. Tuning with the feedback loop closed causes little change in output but may result in instabilities.

a. Remove the FINE FREQ dial and the plate behind it.

b. Disconnect the plate lead and connect a signal generator as shown in Figure 12. Remove the feedback link (see Figure 13) completely.

c. Set the signal-generator frequency to 5 Mc.

d. Set the meter switch on the Type 1113-A to AGC.

e. Set the power switch to ON.

f. After allowing five minutes for warm-up, increase the signal-generator output until the meter shows some deflection.

g. Tune L201 and L202 for maximum meter deflection.

NOTE

Control output of the signal generator so as not to exceed 15 μa on the meter. A 10-μa meter reading should require an input of about 4 mv.

h. Disconnect power.

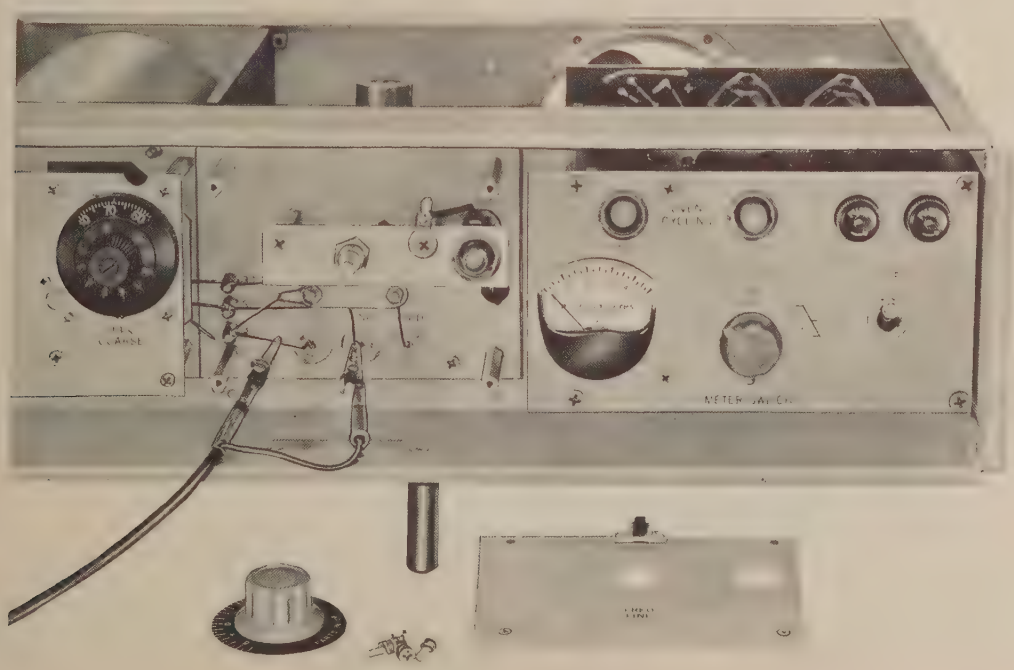


Figure 12. Front View of Type 1113-A.

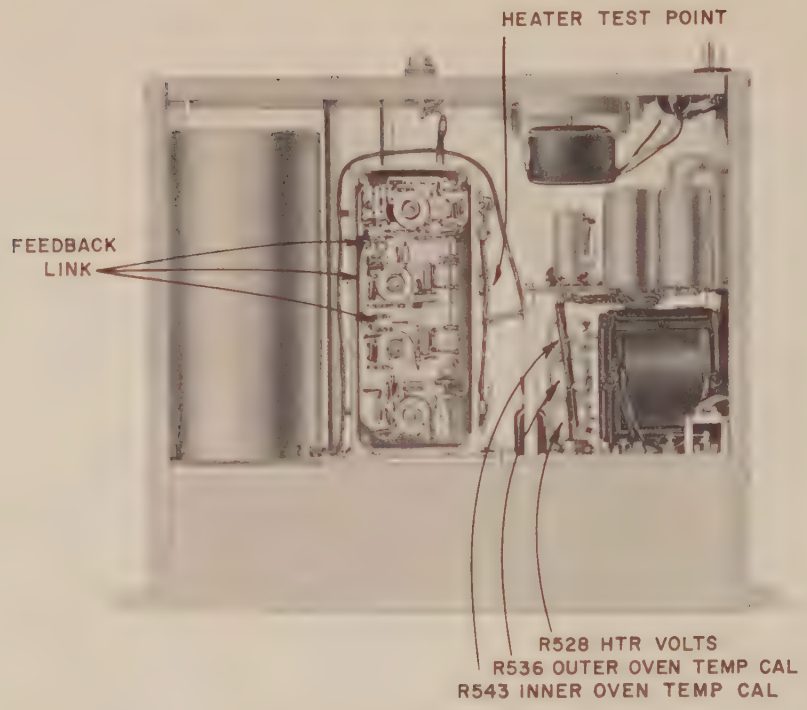


Figure 13. Top View of Type 1113-A.

i. Replace the feedback link and resolder the plate lead.

j. Mount the FINE FREQ plate and dial. To set the dial, turn the shaft fully counterclockwise and set the knob so that the mark on the dial is lined up with the dial indicator.

5.2.3 HEATER VOLTAGE ADJUSTMENT. Connect an accurate (0.5%) dc meter from the heater terminal on the casting (see Figure 13) to the chassis. Adjust potentiometer R528 (marked HTR VOLTS) to 6.5 v ±.05 v.

5.2.4 INNER-OVEN THERMOMETER CALIBRATION. The potentiometer R543 (marked INNER OVEN TEMP CAL) adjusts a thermistor bridge so that the meter reads 25 μa at the proper operating temperature of the crystal. This temperature varies from unit to unit and is listed on page iv of this instruction book. The meter functions as a deviation meter with 25 μa (center) as the normal reading. Sensitivity is approximately ±3° C from nominal. The circuit is shown in Figure 14. When the thermistor is cold its resistance is high and decreases with increasing temperature. At the operating temperature of the oven the TEMP CAL potentiometer has slightly more resistance than the thermistor so that a current of +25 μa flows. Recalibration requires insertion of a very small-gage thermocouple. If the operation of the oven appears otherwise normal, the potentiometer may be set for +25 μa without actual measurement of temperature. "Normal" here means that the frequency of the unit appears to be stable and the oven cycle (cycling lamp) has an on-off ratio of about 1 to 3, say 20 seconds on and 60 seconds off. Moderate departures from these values do not indicate failure, and the figures are for guidance only. It is normal for the temperature to exceed full scale during warm up (see Figure 15). Because of the suppressed zero, the meter may swing from full scale to zero several times during the warm-up period.

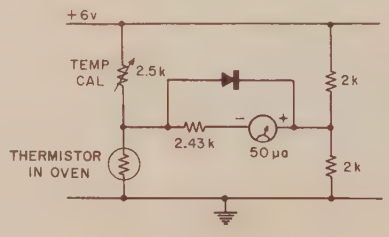


Figure 14. Inner-Oven Thermometer.

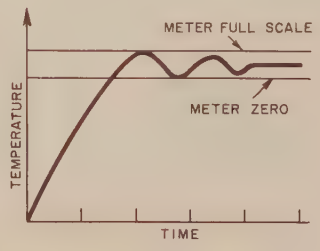


Figure 15. Temperature vs Time During Warm-up.

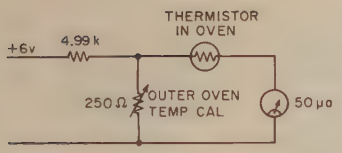


Figure 16. Outer-Oven Thermometer.

5.2.5 OUTER-OVEN TEMPERATURE CALIBRATION. The potentiometer R536 marked OUTER OVEN TEMP CAL may be set at room temperature as follows: Make sure that the ovens have been turned off for at least 24 hours. Measure room temperature. Apply power and set the calibration potentiometer to give room-temperature reading (1 μa for every 2 °C; 25 °C equals 12.5 μa). The scale of this meter is approximately linear from 20 ° to 80 °C. Normal reading of the meter for a hot oven is 27 to 30 μa. See diagram, Figure 16.

5.2.6 CONVERTING TO 230-V OPERATION. The Type 1113-A is normally supplied for 115-volt operation. For 230-volt use the following changes must be made:

Remove the screws from the right-hand panel. The panel can then be swung out supported by its cables, exposing the transformer terminal board. Remove the jumpers from terminal 1 to 3 and 2 to 4 and connect terminal 2 to 3. Make sure not to disturb any other wires connected to these terminals. Replace the 1.2-amp slow-blow fuses supplied for 115 v with 0.6 amp slow-blow fuses, and remove the 115-v nameplate (near power plug).

5.3 TYPE 1114-A FREQUENCY DIVIDER.

5.3.1 POWER SUPPLY. To set the regulator output adjust R802 for -18 volts, as measured from the point indicated in Figure 17 to chassis.

5.3.2 PULSE SHAPER. Connect a 1-Mc signal to the 1-Mc input connector in back of the instrument. Set the DRIVING FREQ switch to 1 Mc. Connect an oscilloscope to the output terminal of the pulse shaper (see Figure 17). Adjust R906 for best sensitivity and output waveform as shown in Figure 18A. Not more than 1 volt peak-to-peak should be required for proper operation.

5.3.3 TYPE 1114-P1 5-TO-1-MC DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Apply a 5-Mc (±1 kc) 1-volt rms signal to the input terminal.

c. Connect an oscilloscope to TP101.

d. Adjust trimmer capacitors C103 and C109 for a maximum 4-Mc signal.

e. Reduce the 5-Mc input to zero. The 4-Mc signal should disappear.

f. Slowly increase the 5-Mc input to 0.35 volt rms. If the 4-Mc signal does not appear, increase the capacitance of C109 slightly for maximum amplitude of the 4-Mc signal. (See Figures 18B and 18C.)

g. Vary the input from 0.3 to 1.6 volts rms and carefully observe the waveform at TP102. There must be no trace of any lower-frequency envelope over the range of input voltage. If there is, adjust C103 slightly until the 1-Mc output at TP102 is clean.

h. Connect a 50-ohm load to the 1-Mc output terminal and an oscilloscope across it. Adjust T102 for maximum amplitude.

i. Set the DRIVING FREQ switch to 5 Mc and connect the oscilloscope to terminal 16 on the female con-

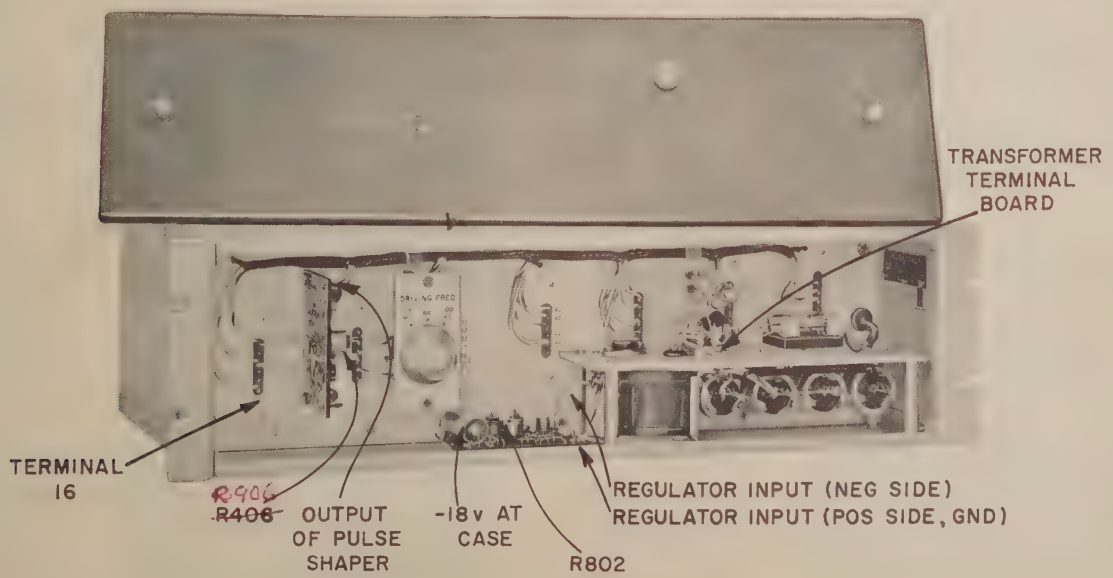
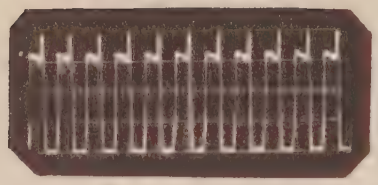
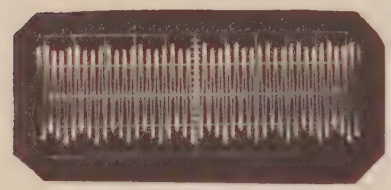


Figure 17. Front View of Type 1114-A.

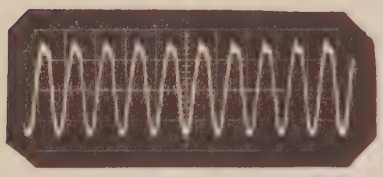
Figure 18 A-O. Oscillograms.



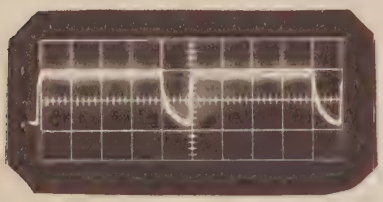
A. Output of pulse shaper. 1 μsec/cm, 2 v/cm.



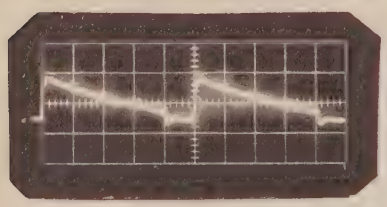
B. TP101
1 μsec/cm,
0.5 v/cm.



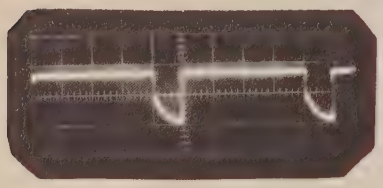
C. TP102.
1 μsec/cm,
0.5 v/cm.



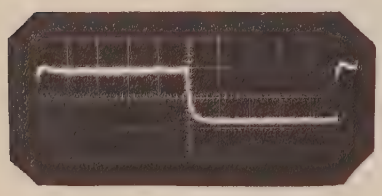
D. TP201
1 μsec/cm,
5 v/cm.



E. TP202
1 μsec/cm,
5 v/cm.

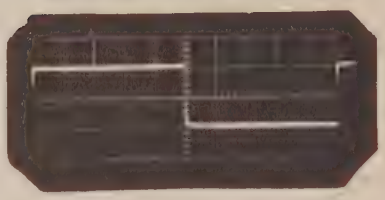


F. TP301
10 μsec/cm,
5 v/cm.

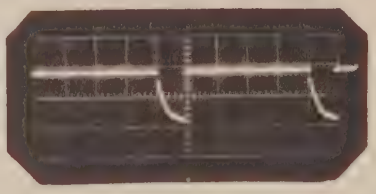


G. TP302
10 μsec/cm,
5 v/cm.

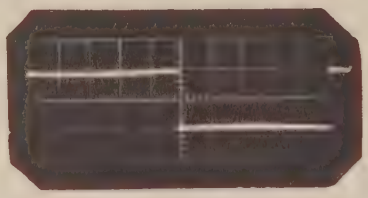
H. TP401
100 μsec/cm,
5 v/cm.



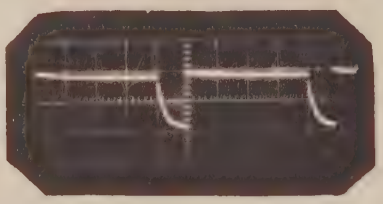
I. TP402.
100 μsec/cm,
5 v/cm.



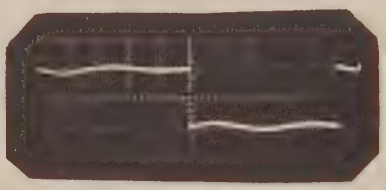
J. TP501.
1 msec/cm,
5 v/cm.



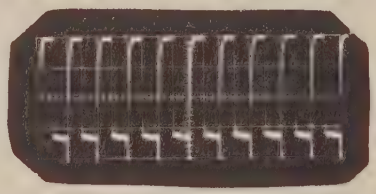
K. TP502.
1 msec/cm,
5 v/cm.



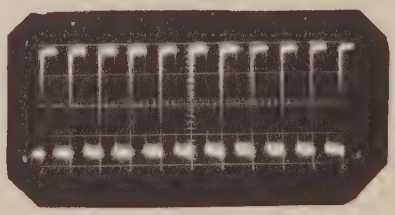
L. TP701.
5 msec/cm,
5 v/cm.



M. TP702.
5 msec/cm,
5 v/cm.



N. 100 KC ⊓⊔
output. 10
μsec/cm,
2 v/cm.



O. 10 KC ⊓⊔
output. 100
μsec/cm,
2 v/cm.

nector for the plug-in unit (the terminal numbers are stamped on the front of the main mounting plate). Adjust T101 for maximum amplitude.

5.3.4 TYPE 1114-P2 1-MC TO 100-KC DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Connect a 5-Mc (±1 kc) 1-volt rms signal to the 5-Mc input terminal.

c. Connect an oscilloscope to TP301 and adjust R208 for a waveform as shown in Figure 18D.

d. Find the limits of the potentiometer (R208) setting, and set the potentiometer for the highest resistance showing proper waveform (this is near the point where the pulse duration increases).

5.3.5 TYPE 1114-P3 100-TO-10-KC DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Connect a 5-Mc (±1 kc) 1-volt rms signal to the 5-Mc input terminal.

c. Connect an oscilloscope to TP301 and adjust R308 for a waveform as shown in Figure 18F.

d. Find the limits of the potentiometer (R308) setting, and set the potentiometer for the highest resistance showing proper waveform (this is near the point where the pulse duration increases).

5.3.6 TYPE 1114-P4 10-TO-1-KC DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Connect a 5-Mc (±1 kc) 1-volt rms signal to the 5-Mc input terminal.

c. Connect an oscilloscope to TP401 and adjust R408 for a waveform as shown in Figure 18H.

d. Find the limits of the potentiometer (R408) setting, and set the potentiometer for the highest resistance showing proper waveform (this is near the point where the pulse duration increases).

5.3.7 TYPE 1114-P5 1-KC TO 100-CPS DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Connect a 5-Mc (±1 kc) 1-volt rms signal to the 5-Mc input terminal.

c. Connect an oscilloscope to TP501 and adjust R509 for a waveform as shown in Figure 18J.

d. Find the limits of the potentiometer (R509) setting, and set the potentiometer for the highest resistance showing proper waveform (this is near the point where the pulse duration increases).

5.3.8 TYPE 1114-P6 400-CPS UNIT. No adjustment of this unit should be required.

5.3.9 TYPE 1114-P7 60-CPS DIVIDER.

a. Remove the unit from the cabinet and connect it to the assembly using the Type 1114-P9 Servicing Extension.

b. Connect a 5-Mc (±1 kc) 1-volt rms signal to the 5-Mc input terminal.

c. Connect an oscilloscope to TP701 and adjust R703 for a waveform as shown in Figure 18L.

d. Find the limits of the potentiometer (R703) setting, and set the potentiometer for the highest resistance showing proper waveform (this is near the point where the pulse duration increases).

5.3.10 230-VOLT OPERATION. The Type 1114-A is normally supplied for 115-volt operation. For 230-volt use, the following changes must be made: On the transformer terminal board on top of the power supply, remove the two jumpers (terminals 1 to 3 and 2 to 4), and connect an insulated jumper between terminals 2 and 3. Replace the 0.1-amp slow-blow fuse with one rated at 0.05 amp.

5.3.11 BATTERY OPERATION. The Type 1114-A can be operated from a 20-to-30-volt battery if the positive side is grounded. Remove the line cord and replace with a cable suitable for battery connection (the line cord may be used if the ac line plug is removed and replaced with a suitable terminal that cannot accidentally connect to the power line). Unsolder the two connections at the left-hand side of the fuse holder. Connect the fuse in the negative lead through a diode to the negative input terminal of the regulator (see Figures 17 and 19). The diode protects the circuit from reversed battery polarity. If it is left out, the regulator will be damaged instantly if the wrong polarity is applied. The diode may be any unit with an inverse rating of at least 50 volts and average forward current of 250 ma. A 1N1692 is suitable.

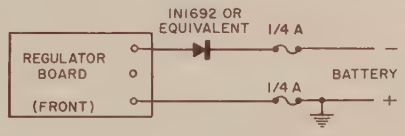


Figure 19. Connections for Battery Operation.

5.4 TYPE 1103-B SYNCRONOMETER.

5.4.1 SERVICE AND MAINTENANCE. The Syncronometer will usually operate for long periods without maintenance. The items most likely to require occasional maintenance are described in the following paragraphs.

The Syncronometer motor includes a vertical spindle, with a plastic rotor surrounded by a 100-tooth rim of magnetic metal. In the rotor is a circular trough with damping vanes, which is partially filled with mercury.

This arrangement provides viscous rotary damping to stabilize the angular velocity of the rotor. The magnetic rim rotates past teeth of matching pitch on the stator magnets. Since there are 100 teeth on the rotor, rotation of this rotor at 10 revolutions per second produces 1000 passages of rotor teeth past each stator tooth during each second. Thus, the synchronous speed of this motor, when driven by a 1000-cps signal, is 10 revolutions per second or 600 rpm. Direct current is superimposed on the 1000-cps signal to polarize the magnetic field.

All bearings in the motor assembly are ball bearings except (1) the gear train driven by the sweep second hand, (2) the pivot bearing of the contactor arm, and (3) the setting mechanism chain drive. The ball bearings normally require no lubrication. The gear reduction following the sweep second hand should not require lubrication since it operates at relatively slow speeds. If the hands bind and do not rotate easily, it may be necessary to clean this gear train. Since this operation requires removal of the motor assembly from the chassis and removal of the hands and dial from the motor assembly, it is recommended that the General Radio Service Department be consulted about the advisability of returning the Syncronometer for servicing.

The 10-to-1 reduction gear between the vertical and horizontal shafts requires very little lubrication. If this gear squeaks, apply a little light, nongumming oil as necessary.

The 30-to-1 worm reduction gear requires very little lubrication - a little light, nongumming oil about once a year.

The setting mechanism is designed to operate stiffly to retain setting. If it slips, clean the brake surfaces.

The cam-follower shoe and pivot require a very small amount of light oil about once a year. It is very important that the cam and shoe be kept free from dirt for best operation of the contactor.

In addition to the cam and shoe, the cam-driven contacts, slip ring, and contact brush should be kept clean. The anvil against which the contact spring bottoms must also be kept clean and free from oil at all times. If the anvil becomes dirty, the contact spring may stick or bounce, causing erratic contact operation.

The bronze gear used to set the contactor position is grounded by a silver-alloy wiper spring. If the gear face becomes dirty or oily and the wiper spring does not ground the gear properly, faulty contact operation may occur.

If it is necessary to adjust the level of the input signal to the 1-kc amplifier tube (V1), set the voltage from the arm of R1 to ground to about 1.0 volt rms, using a vacuum-tube voltmeter. If the motor does not run reliably, check that this voltage is 1.0 volt rms. If this voltage is present but operation is still not reliable, the voltage input may be increased up to 1.5 volts rms. If the motor still fails to operate reliably, check the plate, screen, cathode bias, and heater voltages against those given on page 17. If these voltages are correct, examine the waveforms of the 1000-cps driving voltage. In most cases of unreliable motor operation, difficulty can be traced to transients or phase jumps in the driving signal. These must be eliminated before the motor will run reliably.

If the microdial contactor is to be used with a high-impedance audio signal source, it may be necessary to shunt the microdial contacts with a resistor of a few thousand ohms (4700 ohms is usually low enough) to reduce the effects of stray induced voltages on this lead.

Fuses are mounted on the rear of the chassis for ac line (2), ac starting motor (1), and plate supply voltage (1). A breakdown of the filter capacitors can damage the silicon-diode power rectifiers, since the fuse is in the output lead from the filter. Most other circuit malfunctions will blow a fuse. The starting motor is connected across one 115-volt primary of the power transformer to allow operation on 230-volt lines if required; therefore the starting motor requires an additional fuse.

5.4.2 230-VOLT OPERATION. The Type 1103-B Syncronometer is normally supplied wired for 115-volt service, but can be easily converted to 230-volt operation, as follows: On the power transformer terminal board, remove the two leads from terminals 1 to 3 and 2 to 4. (Do not disturb the motor connections.) Connect an insulated lead between terminals 2 and 3. Replace the two 0.6-ampere fuses with 0.3-ampere fuses. Do not change the starting-motor fuse. Reverse the nameplate on the rear panel so that the 105-125-volt marking will not be visible.

5.4.3 USE OF SYNCRONOMETER WITH TYPE 1102-A MULTIVIBRATOR. There is on the Type 1103-B Syncronometer a special terminal (pin 1 of PL1) for connection to the Type 1102-A Multivibrator. If the 1000-cps driving signal is to be obtained from this source, a shielded cable must be used to connect the Syncronometer to pin 1 of socket SO1 on the Type 1102-A. (This extra cable is supplied when the Syncronometer is ordered for use with the Type 1102-A.)

When the Type 1102-A Multivibrator is used to drive the Syncronometer, the waveform and voltage are such that R5 and C1 (see Figure 20) must be used ahead of R1 to produce the correct driving voltage. Thus the normal input through J1 is not used when the Type 1102-A Multivibrator is used as the source.

[1] Master Lubricant Co., Philadelphia, Pa.

TYPE 1113-A
TABLE OF VOLTAGES AND RESISTANCES

TUBE (TYPE)	PIN	VOLTS DC	RES TO GND
V201 (6688)	1	0	0
	2	-1.2	300 k
	3	0	0
	4	0	0
	5	6.0	<2Ω
	7	175	22 k
	8	0	0
	9	115	19 k
V202 (6688)	1	10	1 k
	2	8.5	200 k
	3	10	1 k
	4	0	0
	5	6.3	<2Ω
	7	190	17 k
	8	0	0
	9	155	38 k
V203 (6688)	1	10	1 k
	2	8.5	200 k
	3	10	1 k
	4	0	0
	5	6.3	<2Ω
	7	190	17 k
	8	0	0
	9	145	38 k
V204 (6922)	1	190	17 k
	2	22	31 k
	3	27	3.17 k
	4	0	0
	5	6.3	<2Ω
	6	160	20 k
	7	8.5	100 k
	8	12.5	0.5 - 1.5 k
	9	0	0
V501 (6AV5GA)	1	185	490 k
	3	200	16 k
	5	320	*
	8	320	*
V502 (6AN8)	1	320	*
	2	170	2.2 M
	3	180	490 k
	6	170	2.2 M
V502 (cont.)	7	200	16 k
	8	90	65 k
	9	94	47 k
V503 (5965)	1	94	47 k
	2	37	500 k
	3	38	6.8 k
	6	128	47 k
	7	36	52 k
	8	38	6.8 k
V504 (5651)	1	80	47 k
	2	0	0
	4	0	0
	5	80	47 k
	7	0	0
V505 (5727)	1	6.3 ac †	133 k
	2, 3	0	0
	4	6.3 ac	<1Ω
	5	0	0
	6	80 ac †	600
	7	0	0
Q501 (2N1138)	E	9.5	Do not attempt to measure these resistances.
	B	9.0	
	C	6.6	
Q502 (2N1372)	E	9.0	
	B	8.8	
	C	4.0	
Q503 (2N445A) BR	E	4.0	
	B	4.1	
	C	8.8	
Q504 (2N445A) BR	E	4.0	
	B	4.1	
	C	6.6	

NOTES:

Conditions of measurement:

1. All voltages measured with VTVM.
2. Power input 115 v, 60 cps.
3. POWER ON
4. Resistance measurements made with power disconnected, POWER switch at STANDBY.

* Leakage resistance of C501B, C501C, and CR501-4, depending on polarity of ohmmeter.

† With inner oven off (INNER OVEN CYCLING lamp off).

TYPE 1103-B
TABLE OF VOLTAGES

	PIN	VOLTS	OHMS
TUBE V1 (6K6GT)	1	NC	NC
	2-7	6.3 ac	0
	3	275 dc	120 k
	4	285 dc	120 k
	5	5.3 ac*	10 k
	8	25 dc	1 k
CLOCK MOTOR TERMINAL STRIP	Starting Motor (115 v)		80
	Clock Motor (1 KC)		160
	Microdial		0 or ∞

NOTES:

* at 1 kc

Voltages are to ground, except heater voltage is measured between pins 2 and 7. Tube pin resistances are to ground. Resistances at clock motor terminal strip are between terminals of indicated pairs.

TYPE 1114-A
TABLE OF VOLTAGES

TRANSISTOR (TYPE)	PIN	DC VOLTS
Q101 (2N1396)	E	-0.3
	B	-0.4
	C	-18
Q102 (2N1372)	E	-2.6
	B	-2.8
	C	-18
Q103 (2N1396)	E	-0.3
	B	-0.9
	C	-18
Q104 (2N1372)	E	-2.6
	B	-2.8
	C	-1.8
Q201 (2N645A)	E	0
	B	0
	C	-18
Q202 (2N582)	E	-9
	B	-8.8
	C	-18
Q203 (2N779)	E	-10.2
	B	-9.6
	C	-10.3
Q204 (2N582)	E	-6.5
	B	-7
	C	-7
Q205 (2N582)	E	-6.5
	B	-5
	C	-16
Q206 (2N169A)	E	-16.1
	B	-16.1
	C	0
Q207 (2N1372)	E	-2.3
	B	-2.5
	C	-18
Q208 (2N169A)	E	-7.7
	B	-7.4
	C	-7.4
Q301 (2N582)	E	0
	B	0
	C	-18
Q302 (2N404)	E	-9.5
	B	-9.1
	C	-18
Q303 (2N520A)	E	-9.5
	B	-9.8
	C	-9.6
Q304 (2N404)	E	-6.5
	B	-7
	C	-7
Q305 (2N404)	E	-6.5
	B	-5
	C	-16
Q306 (2N1374)	E	-9
	B	-9.1
	C	-18
Q307 (2N1374)	E	-8.8
	B	-9
	C	-18
Q308 (2N169A)	E	-7.7
	B	-7.4
	C	-7.4

TRANSISTOR (TYPE)	PIN	DC VOLTS
Q401 (2N404)	E	0
	B	0
	C	-18
Q402 (2N404)	E	-9.4
	B	-9
	C	-18
Q403 (2N520A)	E	-9.4
	B	-9.6
	C	-9.5
Q404 (2N404)	E	-6.5
	B	-7
	C	-7
Q405 (2N404)	E	-6.5
	B	-5
	C	-16
Q406 (2N1374)	E	-8.9
	B	-9
	C	-18
Q407 (2N1374)	E	-8.8
	B	-8.9
	C	-18
Q408 (2N1374)	E	-8.9
	B	-9
	C	-18
Q409 (2N1374)	E	-8.8
	B	-8.9
	C	-18
Q501 (2N404)	E	0
	B	0
	C	-18
Q502 (2N404)	E	-7.2
	B	-7
	C	-18
Q503 (2N520A)	E	-7.2
	B	-7.5
	C	-8.9
Q504 (2N169A)	E	-8.9
	B	-8.7
	C	-8.7
Q505 (2M169A)	E	-17
	B	-16.5
	C	0
Q506 (2N404)	E	-5.8
	B	-5
	C	-16.5
Q507 (2N404)	E	-5.8
	B	-6.2
	C	-6
Q508 (2N1374)	E	-8.9
	B	-9
	C	-18
Q509 (2N1374)	E	-8.7
	B	-8.9
	C	-18
Q601 (2N1374)	E	-1.6
	B	-1.5
	C	-18
Q602 (2N1374)	E	-1.2
	B	-1.6
	C	-8.4

TRANSISTOR (TYPE)	PIN	DC VOLTS
Q603 (2N1374)	E	-8.2
	B	-8.4
	C	-18
Q701 (2N404)	E	-7.2
	B	-6.9
	C	-18
Q702 (2N520A)	E	-7.2
	B	-7.4
	C	-8.7
Q703 (2N404)	E	-5.8
	B	-5
	C	-16.5
Q704 (2N404)	E	-5.8
	B	-6.2
	C	-6
Q705 (2N1374)	E	-9
	B	-9.2
	C	-18
Q706 (2N1374)	E	-8.8
	B	-9
	C	-18
Q801 (2N169A)	E	-8.6
	B	-8.4
	C	-5.4
Q802 (2N169A)	E	-8.6
	B	-8.4
	C	-5.4
Q803 (2N1374)	E	-5.2
	B	-5.4
	C	-13.9
Q804 (2N1374)	E	-5.2
	B	-5.4
	C	-12.4
Q805 (2N1374)	E	-2.7
	B	-2.9
	C	-5.2
Q806 (2N1218)	E	-20 to -30*
	B	-19.5 to -29.5*
	C	-18
Q901 (2N582)	E	-4.4
	B	-4.6
	C	-17
Q902 (2N582)	E	-10.7
	B	-10.9
	C	-11
Q903 (2N582)	E	-10.7
	B	-8.1
	C	-18

NOTES:

conditions of measurement:

1. Power input 115 v, 60 cps.
2. No input signal.
3. All voltages measured with VTVM.

* Depending on line voltage.

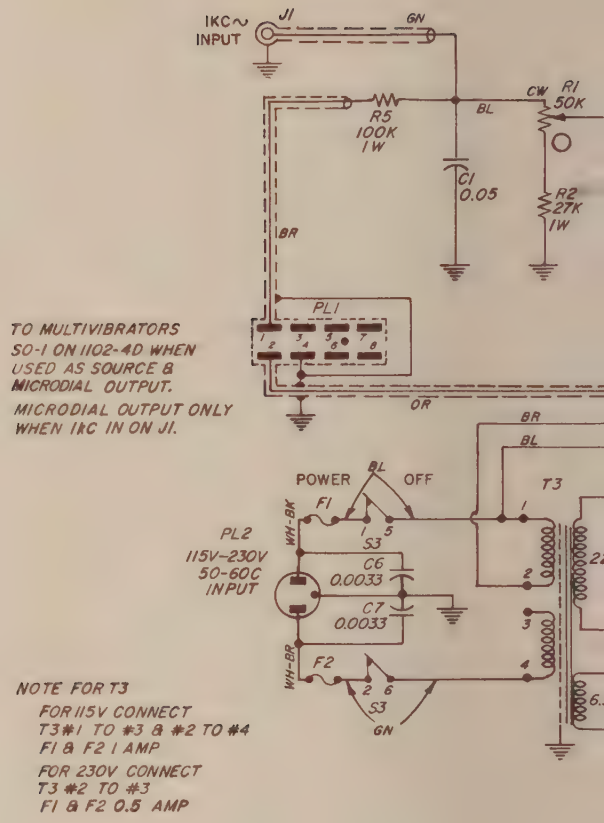
Do not attempt to measure resistances at these transistors.

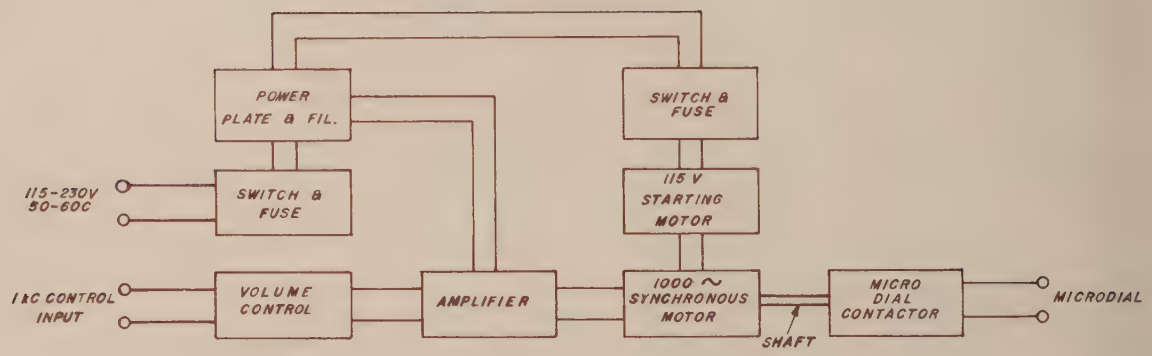
PARTS LIST

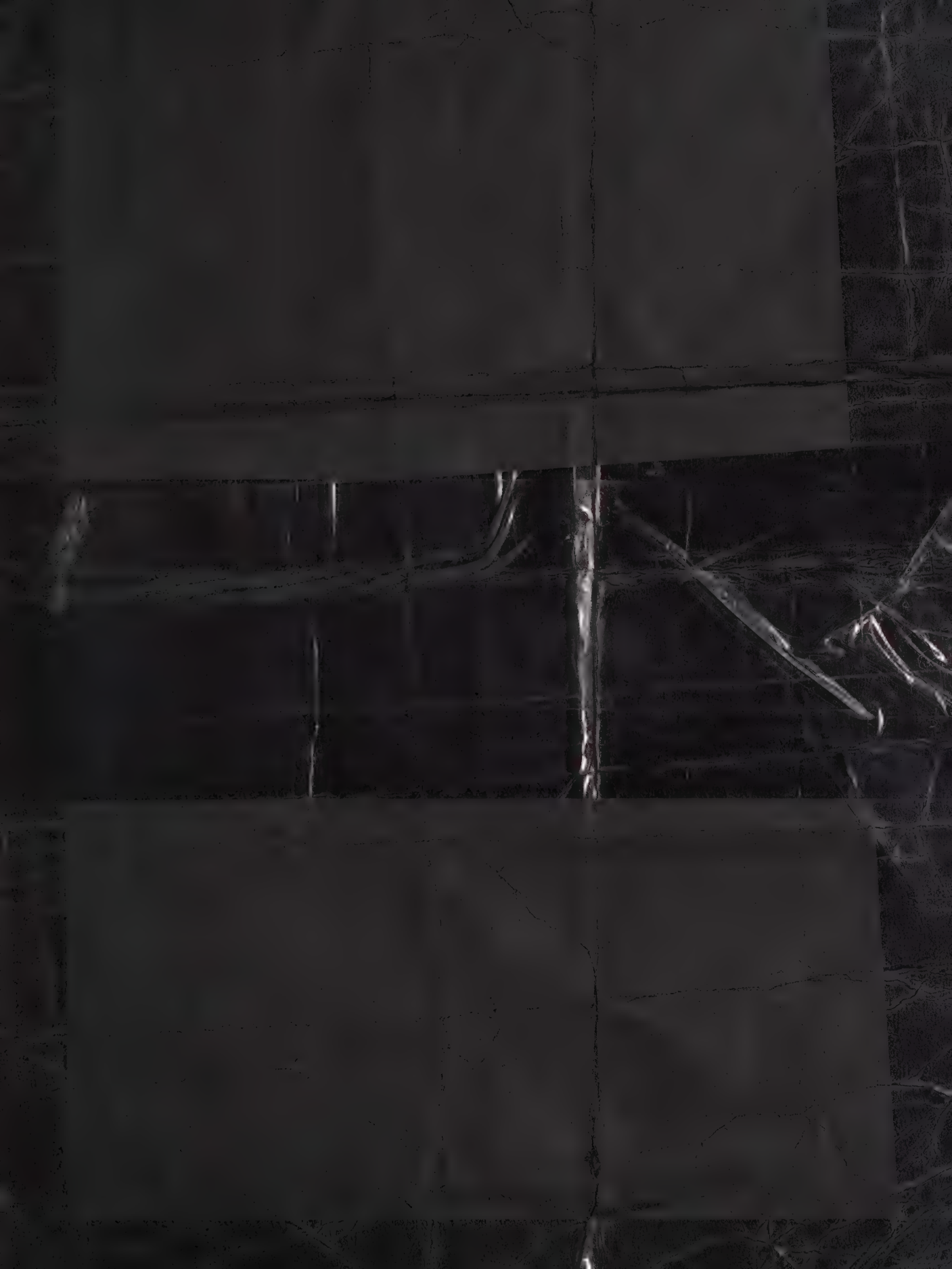
TYPE 1103-B SYNCRONOMETER

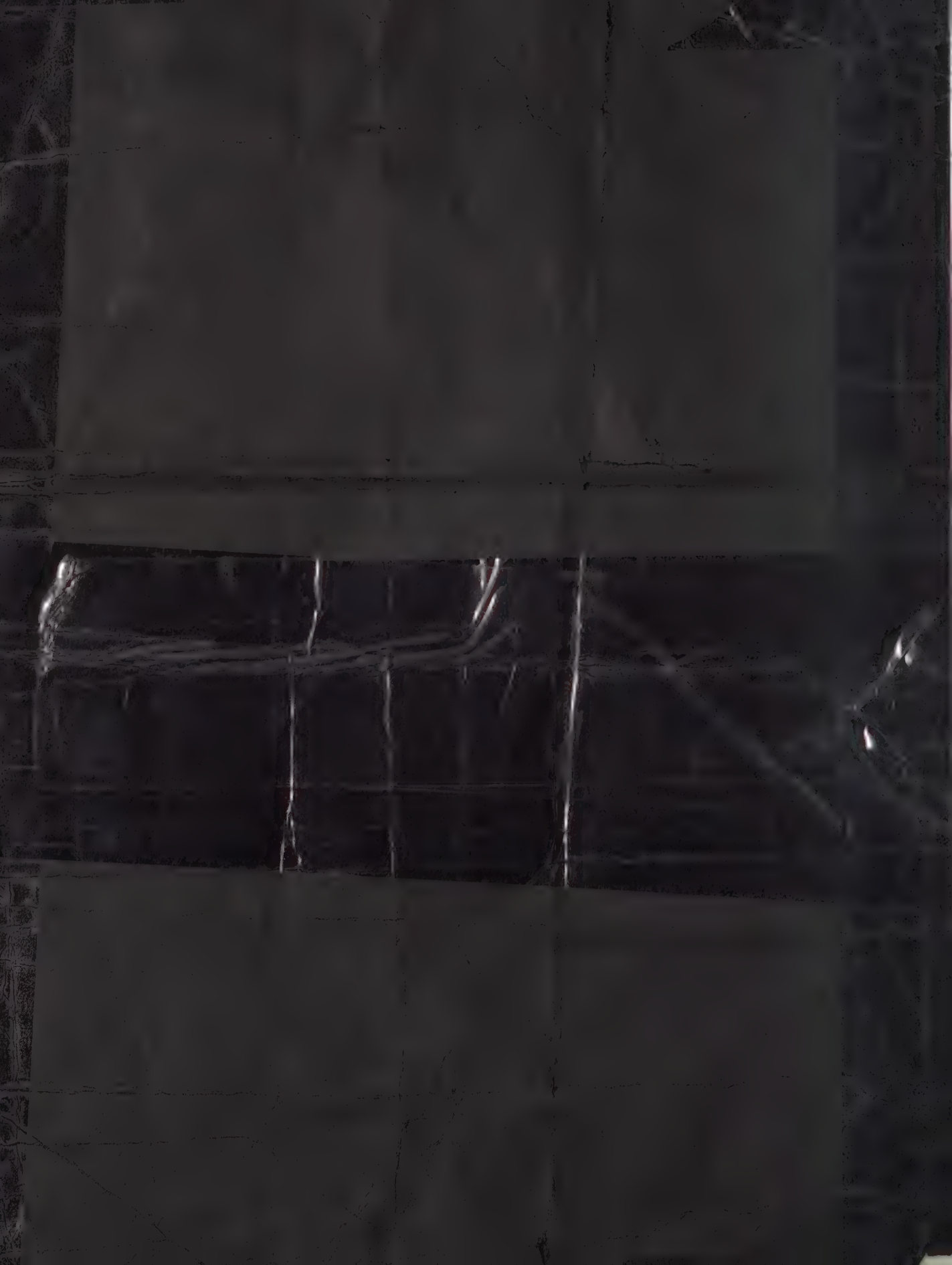
	RESISTORS			PART NO. (NOTE A)
R1	50 k	±5%		973-412
R2	27 k	±10%	1 w	REC-30BF(273C)
R3	680	±10%	2 w	REC-41BF(681C)
R4	1 k	±10%	1 w	REW-4C(102C)
R5	100 k	±10%	1 w	REC-30BF(104C)
R6	1.5	±5%	5 w	REPO-22(015B)
R7	120 k	±10%	2 w	REC-41BF(124C)
	CAPACITORS			**PART NO. (NOTE A)**
C1	0.05 µf	±10%	300 dcwv	COM-50B(503C)
C2	2 µf		600 dcwv	COL-6(205)
C3A	0.0125 µf	±10%	600 dcwv	COM-50B(1252C)
C3B	0.0125 µf	±10%	600 dcwv	COM-50B(1252C)
C4	1 µf		600 dcwv	COL-5(105)
C5A	15 µf		350 dcwv	COE-53
C5B	15 µf			
C6	0.0033 µf	±20%		COC-62(332D)
C7	0.0033 µf	±20%		COC-62(332D)
	MISCELLANEOUS			
CR1	Diode			1N1695
CR2	Diode			1N1695
CR3	Diode			1N1695
CR4	Diode			1N1695
F1	Fuse, 1 amp (0.5 amp for 230 v)			FUF-1
F2	Fuse, 1 amp (0.5 amp for 230 v)			FUF-1
F3	Fuse, 0.2 amp			FUF-2
F4	Fuse, 1 amp			FUF-1
J1	Connector, Coaxial			874-4543
P1	Lamp, 6.3 v, Mazda 44			2LAP-939
P2	Lamp, 6.3 v, Mazda 44			2LAP-939
P3	Lamp, 6.3 v, Mazda 44			2LAP-939
P4	Lamp, 6.3 v, Mazda 44			2LAP-939
S1	Switch, spst			SWT-323,NP
S2	Switch, spst			SWP-809
S3	Switch, dpst			SWT-333,NP
T1	Transformer			345-H
T2	Transformer			693-30
T3	Transformer			0485-4005
V1	Tube			6K6-GT

For notes, see page 21.


1KC~ INPUT
J1
GN
CW
R1 50K
R5 100K 1W
BL
C1 0.05
R2 27K 1W
BR
PL1
TO MULTIVIBRATORS SO-1 ON 1102-4D WHEN USED AS SOURCE & MICRODIAL OUTPUT.
MICRODIAL OUTPUT ONLY WHEN 1&C IN ON J1.
OR
POWER
OFF
F1
S3
T3
PL2
115V-230V 50-60C INPUT
WH-BK
C6 0.0033
C7 0.0033
F2
WH-BR
NOTE FOR T3
FOR 115V CONNECT T3 #1 TO #3 & #2 TO #4 F1 & F2 1 AMP
FOR 230V CONNECT T3 #2 TO #3 F1 & F2 0.5 AMP


POWER PLATE & FIL.
SWITCH & FUSE
115-230V 50-60C
SWITCH & FUSE
115 V STARTING MOTOR
1&C CONTROL INPUT
VOLUME CONTROL
AMPLIFIER
1000 ~ SYNCHRONOUS MOTOR
SHAFT
MICRO DIAL CONTACTOR
MICRODIAL





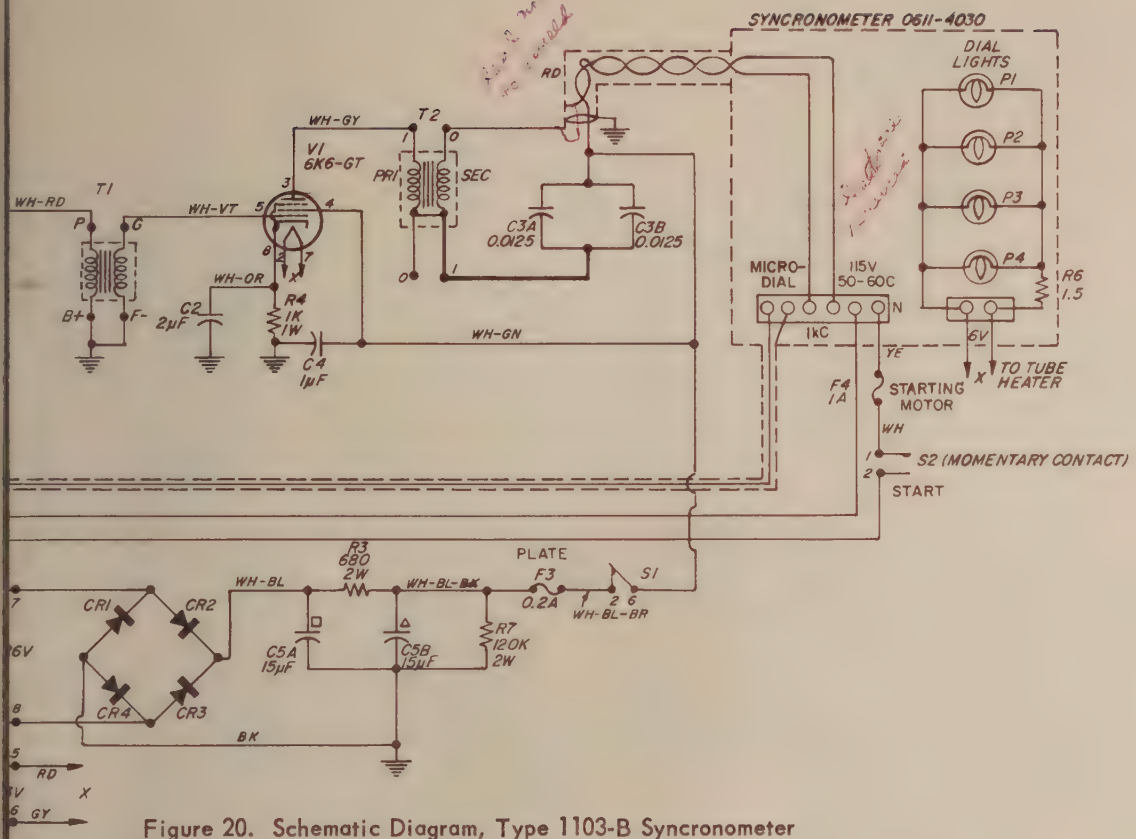
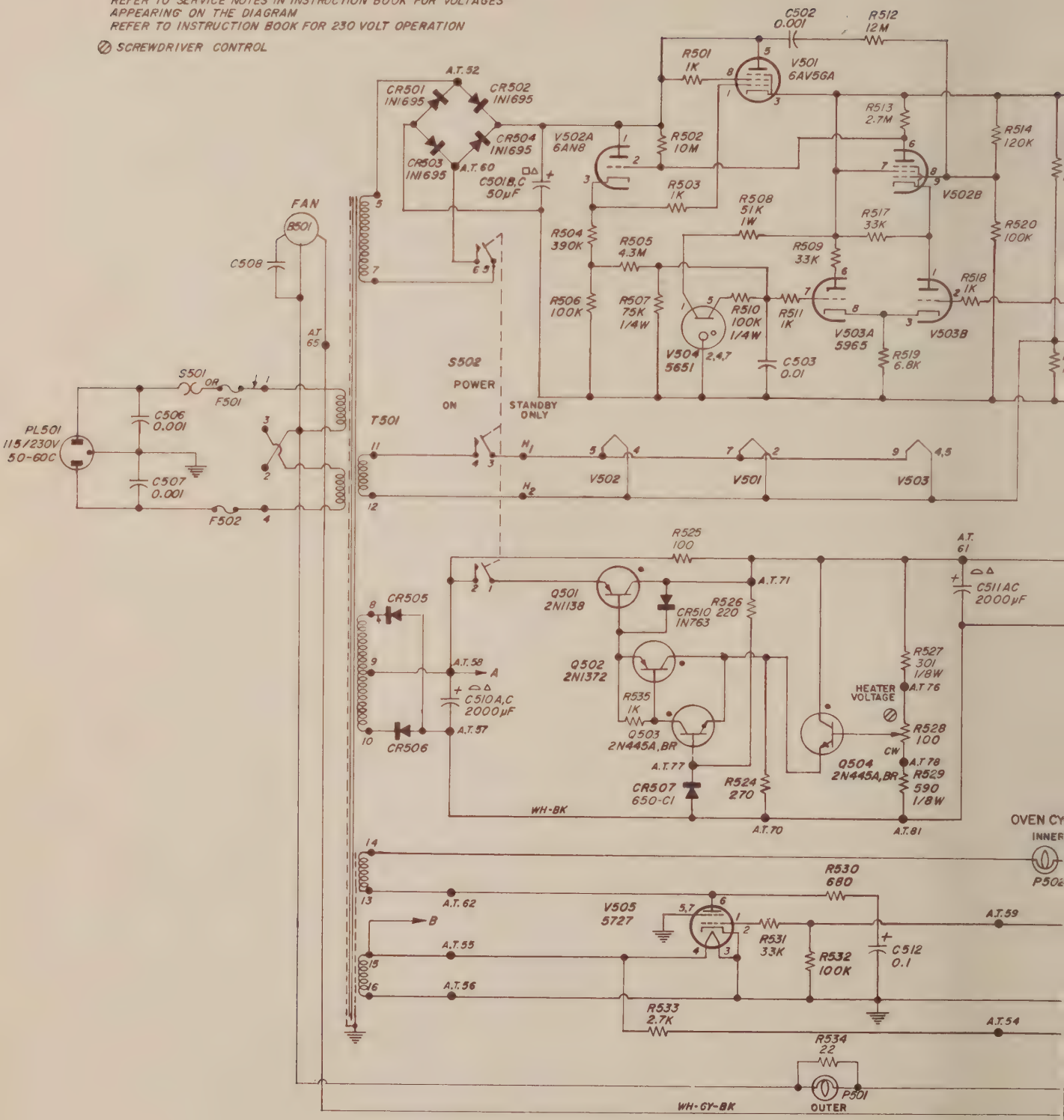


Figure 20. Schematic Diagram, Type 1103-B Syncronometer

Block Diagram

NOTES:
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 OHMS M= 1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN PICOFARADS,
LESS THAN ONE IN MICROFARADS UNLESS OTHERWISE SPECIFIED
REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES
APPEARING ON THE DIAGRAM
REFER TO INSTRUCTION BOOK FOR 230 VOLT OPERATION
⊘ SCREWDRIVER CONTROL



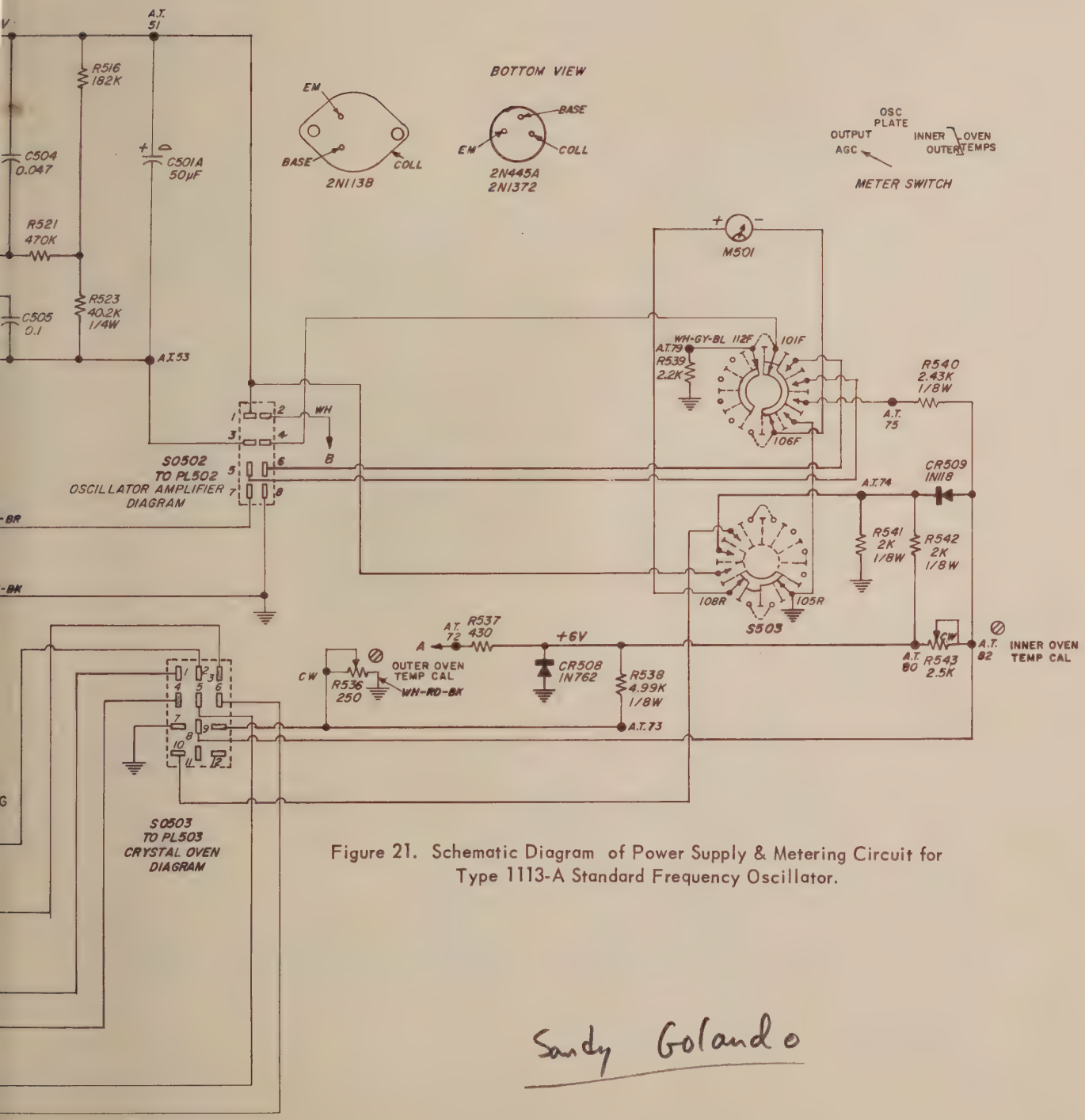


Figure 21. Schematic Diagram of Power Supply & Metering Circuit for Type 1113-A Standard Frequency Oscillator.

Sandy Golando

PARTS LIST

TYPE 1113-A STANDARD FREQUENCY OSCILLATOR

CAPACITORS (NOTE A)				
C201	0.001 µf	±10%	500 dcwv	COC-3(102C)
C202	0.001 µf	±10%	500 dcwv	COC-3(102C)
C203	0.01 µf	±20%	500 dcwv	COC-62(103D)
C204	0.01 µf	±20%	500 dcwv	COC-61-3(103D)
C206	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C207	0.01 µf	±20%	500 dcwv	COC-62(103D)
C208	0.01 µf	±20%	500 dcwv	COC-62(103D)
C209	47 pf	±5%NPO	500 dcwv	COC-62-2(470B)
C213	150 pf	±2%	500 dcwv	COM-5E(151A1)
C214	0.01 µf	±20%	500 dcwv	COC-62(103D)
C215	0.1 µf	+80-20%	50 dcwv	COC-63-3(104D)
C216	0.01 µf	±20%	500 dcwv	COC-62(103D)
C217	0.01 µf	±20%	500 dcwv	COC-62(103D)
C218	0.001 µf	±10%	500 dcwv	COC-3(102C)
C219	2.4 pf	±5%	500 dcwv	COC-1(024B)
C220	150 pf	±2%	500 dcwv	COM-5E(151A1)
C221	47 pf	±10%N750	500 dcwv	COC-21(470C)
C222	0.001 µf	±5%	500 dcwv	COM-5D(102B)
C223	0.1 µf	+80-20%	50 dcwv	COC-63-3(104D)
C224	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C225	0.01 µf	±20%	500 dcwv	COC-62(103D)
C226	0.01 µf	±20%	500 dcwv	COC-62(103D)
C227	0.001 µf	±10%	500 dcwv	COC-3(102C)
C229	47 pf	±10%N750	500 dcwv	COC-21(470C)
C230	0.01 µf	±20%	500 dcwv	COC-62(103D)
C231	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C232	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C233	24 pf	±5%NPO	500 dcwv	COC-62-2(240B)
C234	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C235	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C236	0.001 µf	±10%	500 dcwv	COC-3(102C)
C237	0.001 µf	±10%	500 dcwv	COC-3(102C)
C238	0.01 µf	±20%	500 dcwv	COC-62(103D)
C239	47 pf	±5%NPO	500 dcwv	COC-62-2(470B)
C240	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C241	0.001 µf	±10%	500 dcwv	COC-3(102C)
C242	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C243	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C244	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C245	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C246	0.01 µf			368-4180
C501A	50 µf			
C501B	25 µf		450 dcwv	COE-10
C501C	25 µf			
C502	0.001 µf	±20%	500 dcwv	COC-60(102D)
C503	0.01 µf	±20%	500 dcwv	COC-62(103D)
C504	0.047 µf	±10%	400 dcwv	COW-25(473C)
C505	0.01 µf	±20%	500 dcwv	COC-62(103D)
C506	0.001 µf	±20%	500 dcwv	COC-60(102D)
C507	0.001 µf	±20%	500 dcwv	COC-60(102D)
C508	0.75 µf (Part of B501)			MOD-32-2
C510A	1000 µf			
C510C	1000 µf		15 dcwv	COEB-32
C511A	1000 µf			
C511C	1000 µf		15 dcwv	COEB-32
C512	0.1 µf	±10%	100 dcwv	COW-17
C601	0.01 µf	±20%	500 dcwv	COC-62(103D)
C602				1113-41
C603	16 pf	±5%NPO	50 dcwv	COC-61-2(160B)
C604	178 pf	±1%	500 dcwv	COM-5F(1780A)
C605	267 pf	±1%	500 dcwv	COM-5F(2670A)

RESISTORS (NOTES A, B)				
R201	47.5 k	±1%	1/8 w	REF-60(4752A)
R202	499	±1%	1/8 w	REF-60(4990A)
R203	6.8 k	±5%	1/2 w	REC-20BF(682B)
R204	20 k	±5%	1 w	REC-30BF(203B)
R205	33	±5%	1/2 w	REC-20BF(330B)
R206	33	±5%	1/2 w	REC-20BF(330B)
R207	100 k	±5%	1/2 w	REC-20BF(104B)
R208	47 k	±5%	1/2 w	REC-20BF(473B)
R209	33 k	±5%	1 w	REC-30BF(333B)
R211	1 k	±5%	1/2 w	REC-20BF(102B)
R212	10 k	±5%	1/2 w	REC-20BF(103B)
R213	22 k	±5%	1/2 w	REC-20BF(223B)
R214	33	±5%	1/2 w	REC-20BF(330B)
R215	100 k	±5%	1/2 w	REC-20BF(104B)
R216	100 k	±5%	1/2 w	REC-20BF(104B)
R217	1 k	±5%	1/2 w	REC-20BF(102B)
R218	46.4	±1%	1/8 w	REF-60(0464A)
R219	75	±5%	1/2 w	REC-20BF(750B)
R220	33	±5%	1/2 w	REC-20BF(330B)
R221	100 k	±5%	1/2 w	REC-20BF(104B)
R222	100 k	±5%	1/2 w	REC-20BF(104B)
R223	10 k	±5%	1/2 w	REC-20BF(103B)
R224	1 k	±5%	1/2 w	REC-20BF(102B)
R225	22 k	±5%	1/2 w	REC-20BF(223B)
R226	200 k	±5%	1/2 w	REC-20BF(204B)
R227	1 k	±5%	1/2 w	REC-20BF(102B)
R228	9.1 k	±5%	1/2 w	REC-20BF(912B)
R229	56	±5%	1/2 w	REC-20BF(560B)
R230	270 k	±5%	1/2 w	REC-20BF(274B)
R231	1 k	±5%	1/2 w	REC-20BF(102B)
R232	40.2 k	±0.5%		ZREPR-55(4022AA)
R233	33 k	±5%	1/2 w	REC-20BF(333B)
R234	33 k	±5%	1/2 w	REC-20BF(333B)
R235	3.16 k	±0.5%		ZREPR-6S(1821AA)
R236				1113-2000
R237	1.82 k	±0.5%		ZREPR-6S(1821AA)
R238	47 k	±5%	1/2 w	REC-20BF(473B)
R239	97.6 k	±1%	1/8 w	REF-60(9762A)
R240	100 k	±5%	1/2 w	REC-20BF(104B)
R241	5.1 k	±5%	1/2 w	REC-20BF(512B)
R242	510	±5%	1/2 w	REC-20BF(511B)
R243	1 k	±20%	1/2 w	1113-44
R244	124 k	±1%	1/8 w	REF-60(1243A)
R245	6.8	±10%	1/2 w	REW-3C(068C)
R501	1 k	±5%	1/2 w	REC-20BF(102B)
R502	10 M	±5%	1/2 w	REC-20BF(106B)
R503	1 k	±5%	1/2 w	REC-20BF(102B)
R504	390 k	±5%	1/2 w	REC-20BF(394B)
R505	4.3 M	±5%	1/2 w	REC-20BF(435B)
R506	100 k	±5%	1/2 w	REC-20BF(104B)
R507	75 k	±1%	1/4 w	REF-65(753A)
R508	51 k	±5%	1 w	REC-30BF(513B)
R509	33 k	±5%	1/2 w	REC-20BF(333B)
R510	100 k	±1%	1/4 w	REF-65(104A)
R511	1 k	±5%	1/2 w	REC-20BF(102B)
R512	12 M	±5%	1/2 w	REC-20BF(126B)
R513	2.7 M	±5%	1/2 w	REC-20BF(275B)
R514	120 k	±5%	1/2 w	REC-20BF(124B)
R515	2.2 M	±5%	1/2 w	REC-20BF(225B)
R516	182 k	±1%	1/2 w	REF-70(1823A)
R517	33 k	±5%	1/2 w	REC-20BF(333B)

For notes, see page 21

PARTS LIST (cont)

RESISTORS (NOTES A, B)

R518	1 k	±5%	1/2 w	REC-20BF(102B)
R519	6.8 k	±5%	1/2 w	REC-20BF(682B)
R520	100 k	±5%	1/2 w	REC-20BF(104B)
R521	470 k	±5%	1/2 w	REC-20BF(474B)
R522	1.5 M	±5%	1/2 w	REC-20BF(155B)
R523	40.2 k	±1%	1/4 w	REF-65(4022A)
R524	270	±5%	1/2 w	REC-20BF(271B)
R525	100	±5%	1/2 w	REC-20BF(101B)
R526	220	±5%	1/2 w	REC-20BF(221B)
R527	301	±1%	1/8 w	REF-60(3010A)
R528	100	±10%	2 w	POSW-3(101C)
R529	590	±1%	1/8 w	REF-60(591A)
R530	680	±5%	1/2 w	REC-20BF(681B)
R531	33 k	±5%	1/2 w	REC-20BF(333B)
R532	100 k	±5%	1/2 w	REC-20BF(104B)
R533	2.7 k	±5%	1/2 w	REC-20BF(272B)
R534	22	±5%	1/2 w	REC-20BF(220B)
R535	1 k	±5%	1/2 w	REC-20BF(102B)
R536	250	±10%	2 w	POSW-3(251C)
R537	430	±5%	1/2 w	REC-20BF(431B)
R538	4.99 k	±1%	1/8 w	REF-60(4991A)
R539	2.2 k	±5%	1/2 w	REC-20BF(222B)
R540	2.43 k	±1%	1/8 w	REF-60(2431A)
R541	2.00 k	±1%	1/8 w	REF-60(202A)
R542	2.00 k	±1%	1/8 w	REF-60(202A)
R543	2.5 k	±10%	2 w	POSW-3(252C)
R601	Outer oven heater			Part of 1113-231
R602	47 k	±5%	1/2 w	REC-20BF(473B)
R603	Thermistor			1113-401
R604	Thermistor			1113-401
R605	Inner oven heater			Part of 1113-233
R606	Anticipator			Part of 1113-234
R607	47	±5%	5 w	REC-5(470B)
R608	47	±5%	5 w	REC-5(470B)

RECTIFIERS & DIODES

CR201	1N252	CR504	1N1695
CR202	1N251	CR505	2RE-41
CR203	1N251	CR506	2RE-41
CR204	1N191	CR507	650-CI
CR501	1N1695	CR508	1N762
CR502	1N1695	CR509	1N118
CR503	1N1695	CR510	1N763

INDUCTORS

L201	4.5 - 8.6 µh		CHA-59-4
L202	4.5 - 8.6 µh		CHA-59-4
L204	18 µh	±10%	CHM-1(180C)
L205	12 µh	±10%	CHM-1(120C)
L206	12 µh	±10%	CHM-1(120C)
L207	12 µh	±10%	CHM-1(120C)
L601			1113-236-2
L602			1113-236

MISCELLANEOUS

B501	Fan Motor	MOD-32
F501	Fuse, 1.2 amp Slo-Blo	FUF-1
F502	Fuse, 1.2 amp Slo-Blo	FUF-1
J201	Connector, Coaxial	874-4502
J202	Connector, Coaxial	874-4502
M501	Meter	MEDS-99
P201	Lamp, Mazda No. 44	2LAP-939
P501	Lamp	2LAP-939F
P502	Lamp	2LAP-939F
PL201	Plug	CDMP-1275-8
PL501	Plug	CDPP-10
PL502	Plug	CDMP-1275-12
PL503	Plug	CDMP-1275-12
PL601	Plug	1113-49
S501	Thermoswitch, spst	TH-4-2
S502	Switch, 3pst	1113-46
S503	Switch, Rotary	SWRW-202
S601	Thermoswitch, spst	TH-4-2
S602	Thermostat	1113-4040
S603	Thermoswitch, spst	TH-4
S0502	Socket	CDMS-1262-8
S0503	Socket	CDMS-1262-12
S0601	Socket	1113-49-2
T201	Transformer	1113-202
T501	Transformer	365-494
X601	Crystal	1113-42

TUBES

V201	6688	V204	6922	V503	5965
V202	6688	V501	6AV5GA	V504	5651
V203	6688	V502	6AN8	V505	5727

TRANSISTORS

Q501	2N1138	Q503	2N445A,BR
Q502	2N1372	Q504	2N445A,BR

NOTES

A) COC - Capacitor, ceramic
COE - Capacitor, electrolytic
COEB - Capacitor, electrolytic block
COL - Capacitor, oil
COM - Capacitor, mica
COP - Capacitor, plastic
COT - Capacitor, trimmer
COW - Capacitor, wax
POSC - Potentiometer, composition
POSW - Potentiometer, wire-wound
REC - Resistor, composition
REF- Resistor, film
REPO - Resistor, power
REPR - Resistor, precision
REW - Resistor, wire-wound

B) Resistances are in ohms except as otherwise indicated.

NOTES: RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED, K= 1000 OHMS, M= 1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS UNLESS OTHERWISE SPECIFIED
INDUCTANCE VALUES IN MICROHENRIES
REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON THE DIAGRAM AND ALSO FOR THE D-C RESISTANCE OF IRON CORED INDUCTORS

⊘ SCREWDRIVER CONTROL
○ KNOB CONTROL

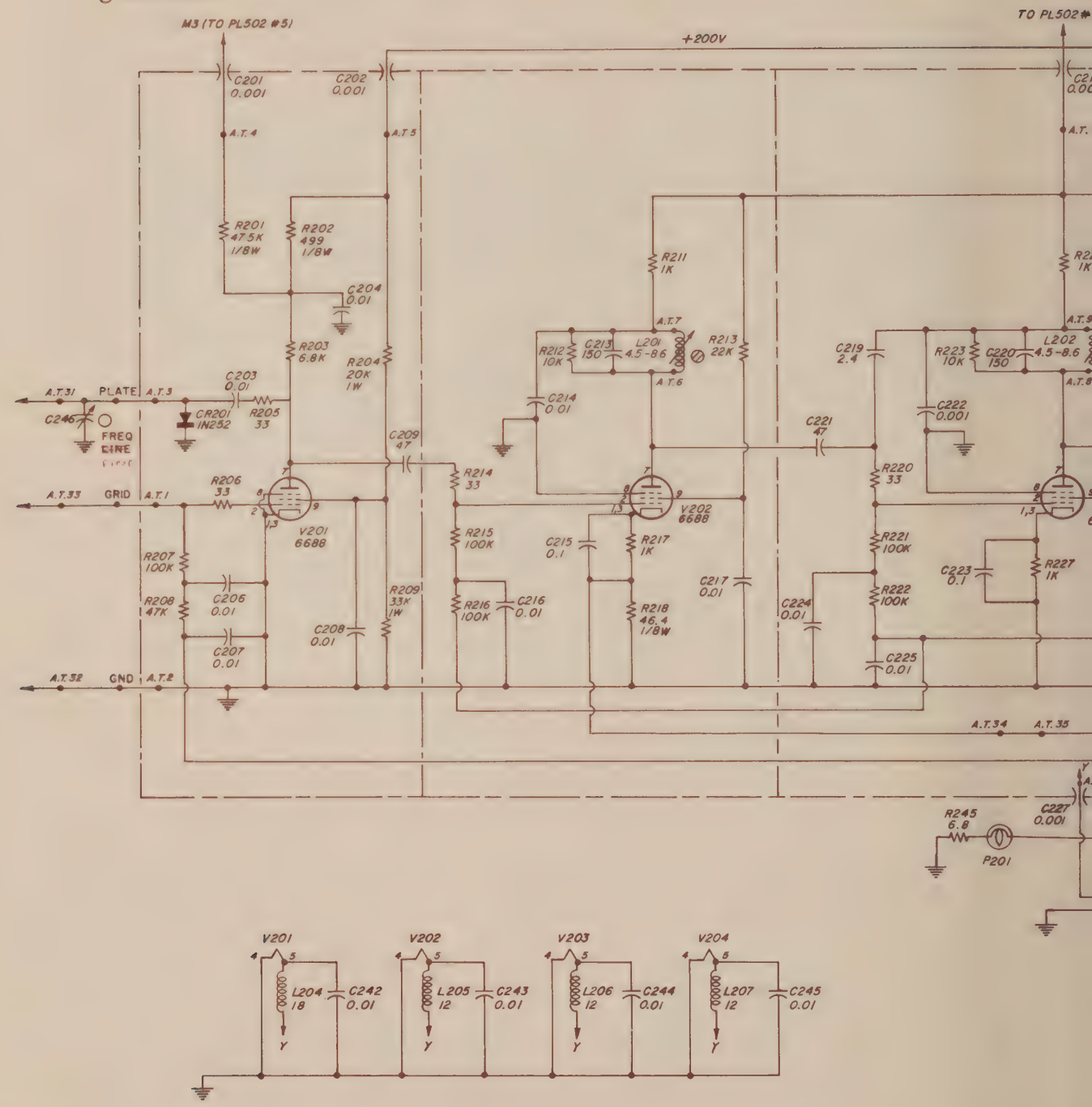
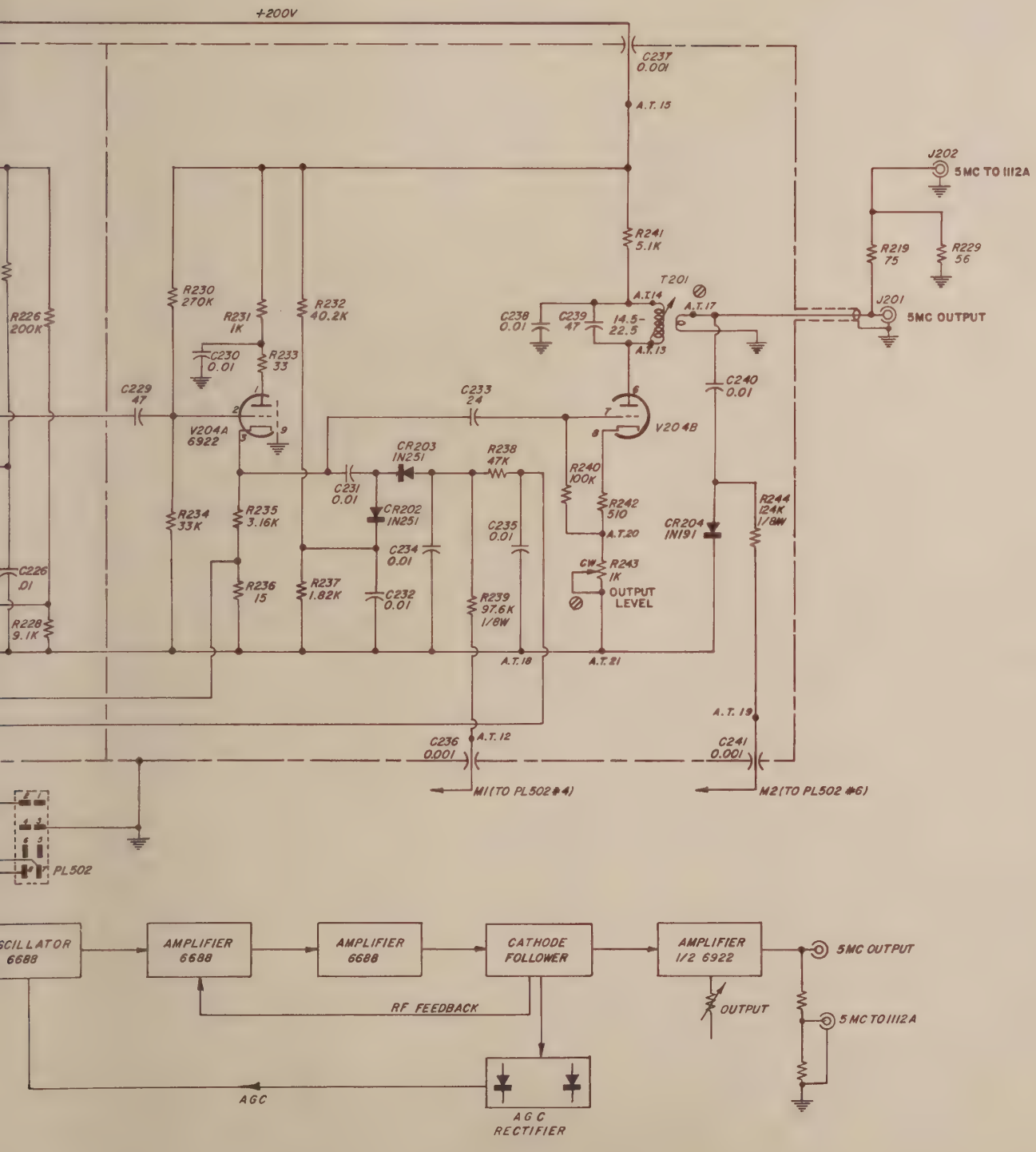
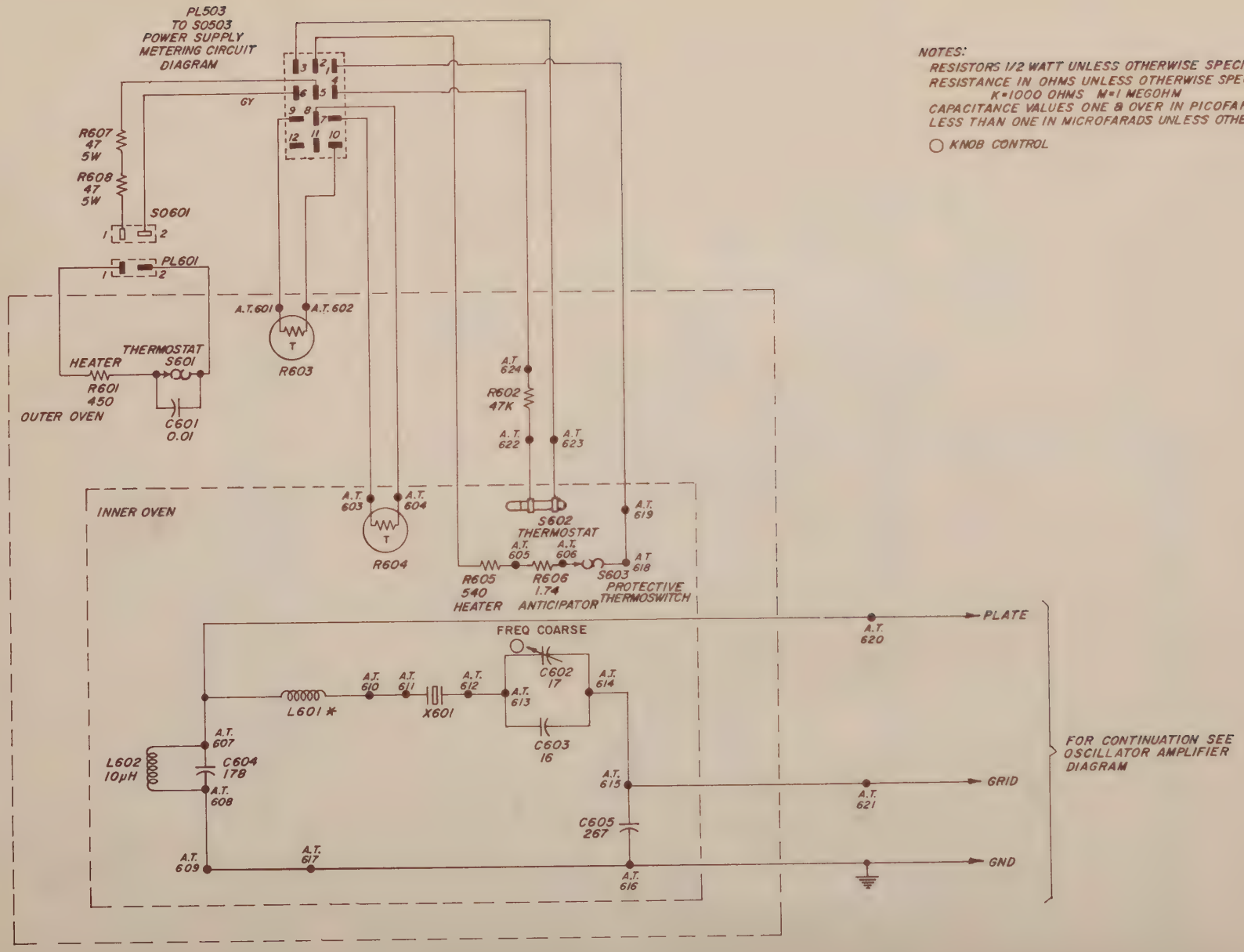


Figure 22. Schematic Diagram of Oscillator Amplifier for Type 1113-A Standard Frequency Oscillator.

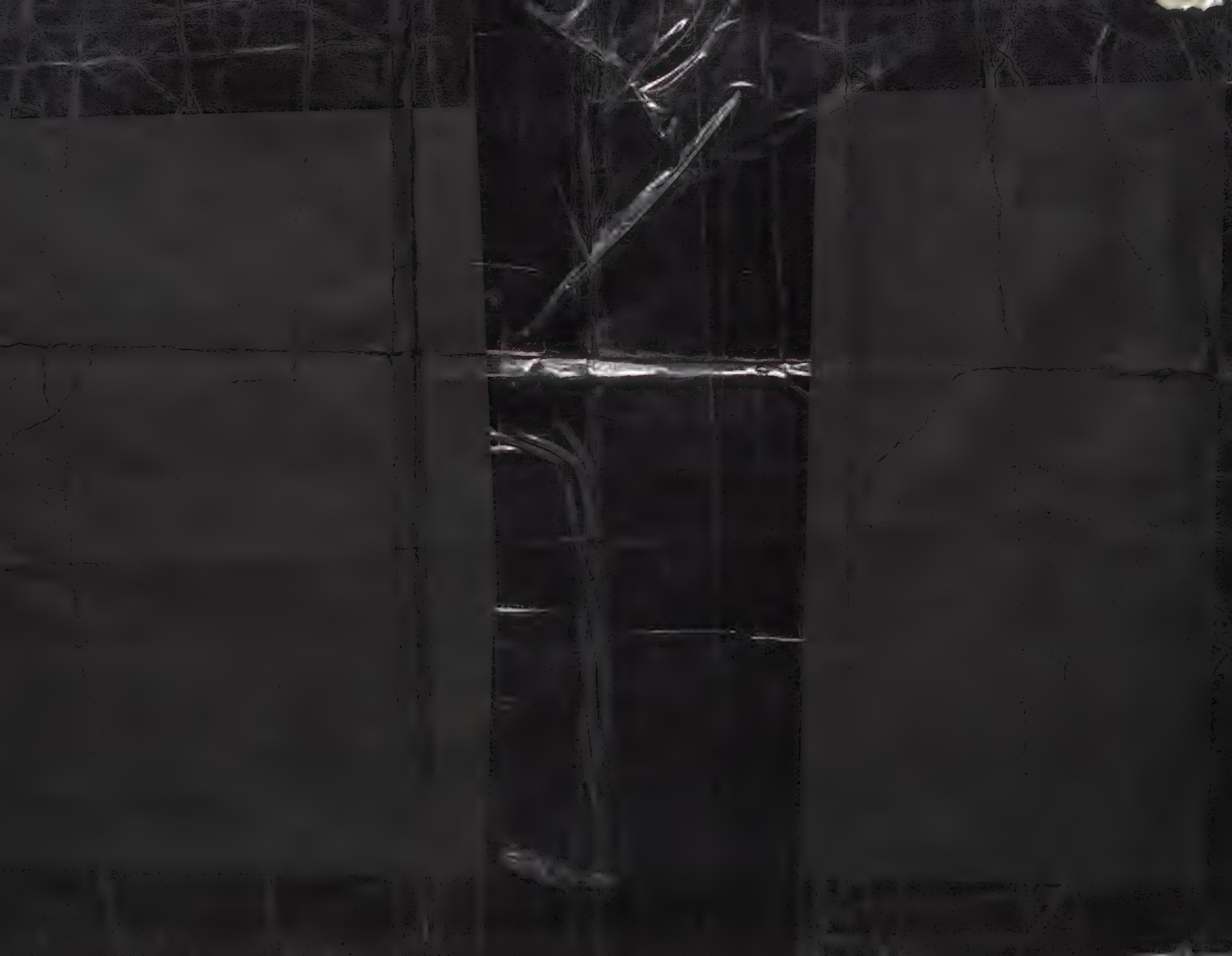


Block Diagram of Oscillator Amplifier for Type 1113-A Standard Frequency Oscillator.



NOTES:
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 OHMS M=1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN PICOFARADS,
LESS THAN ONE IN MICROFARADS UNLESS OTHERWISE SPECIFIED
○ KNOB CONTROL

Figure 23. Schematic Diagram for Type 1113-A Crystal Oven.



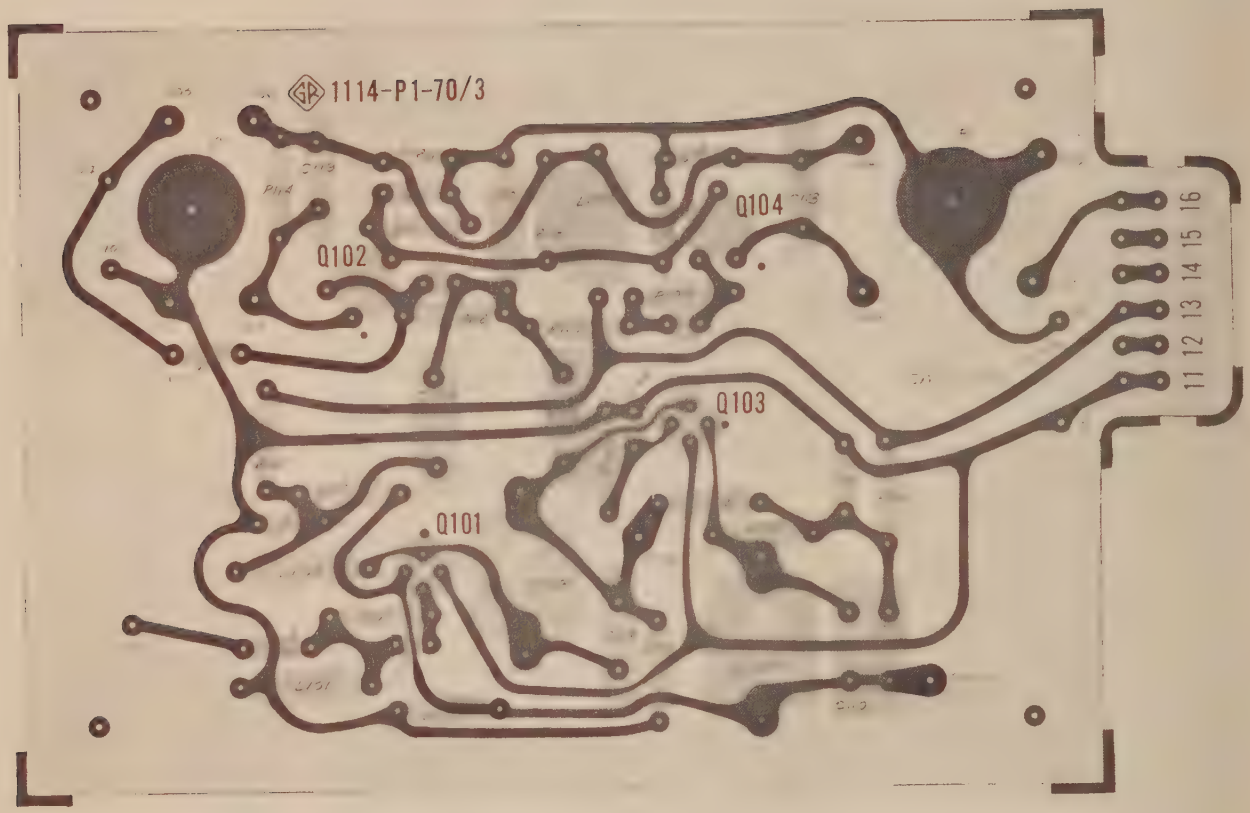


Figure 24a. Etched Board Layout, Type 1114-P1 1-Mc Plug-In Unit.

PARTS LIST

TYPE 1114-P1 1-MC PLUG-IN UNIT

	RESISTORS			PART NO. (NOTE A)
R101	2.2 k	±5%	1/2 w	REC-20BF(222B)
R102	12 k	±5%	1/2 w	REC-20BF(123B)
R103	470 k	±5%	1/2 w	REC-20BF(474B)
R104	470	±5%	1/2 w	REC-20BF(471B)
R105	220 k	±5%	1/2 w	REC-20BF(224B)
R106	12 k	±5%	1/2 w	REC-20BF(123B)
R107	1.5 k	±5%	1/2 w	REC-20BF(152B)
R108	1 k	±5%	1/2 w	REC-20BF(102B)
R109	1.5 k	±5%	1/2 w	REC-20BF(152B)
R110	180	±5%	1/2 w	REC-20BF(181B)
R111	1.2 k	±5%	1/2 w	REC-20BF(122B)
R112	560	±5%	1/2 w	REC-20BF(561B)
R113	6.2 k	±5%	1/2 w	REC-20BF(622B)
R114	36 k	±5%	1/2 w	REC-20BF(363B)

	CAPACITORS			PART NO. (NOTE A)
C101	0.01 µf	±20%	500 dcwv	COC-62(103D)
C102	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C103	7-45 pf			COT-12
C104	237 pf	±2%	500 dcwv	COM-5E(2370A1)
C105	0.01 µf	±5%	500 dcwv	COM-1D(103B)
C106	0.01 µf	±5%	500 dcwv	COM-1D(103B)
C107	0.0047 µf	±20%	500 dcwv	COC-62(472D)
C108	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C109	5-20 pf			COT-18
C110	95.3 pf	±2%	500 dcwv	COM-5E(0953A1)
C111	0.0022 µf	±5%	500 dcwv	COM-5D(222B)
C112	0.02 µf	+80-20%	50 dcwv	COC-62-3(203D)
C113	787 pf	±2%	500 dcwv	COM-5E(7870A1)
C114	0.05 µf	+80-20%	50 dcwv	COC-63-3(503D)
C115	0.02 µf	+80-20%	50 dcwv	COC-62-3(203D)
C116	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C117	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C118	0.02 µf	+80-20%	50 dcwv	COC-62-3(203D)
C119	787 pf	±2%	500 dcwv	COM-5E(7870A1)
C120	0.05 µf	+80-20%	50 dcwv	COC-63-3(503D)
C121	180 pf	±5%	500 dcwv	COC-60(181B)

	MISCELLANEOUS	
J101	Connector, Coaxial	874-4501
J102	Connector, Coaxial	874-4501
L101	Choke, 33 µh	CHM-2(330)
L102	Inductor	1114-P1-40
L103	Inductor	1114-P1-40
L104	Choke, 15 µh	CHM-1(150)
L105	Choke, 1 mh	CHM-6(102)
Q101	Transistor	2N1396
Q102	Transistor	2N1372
Q103	Transistor	2N1396
Q104	Transistor	2N1372
T101	Transformer	1114-P1-200
T102	Transformer	1114-P1-200

For notes, see page 21.

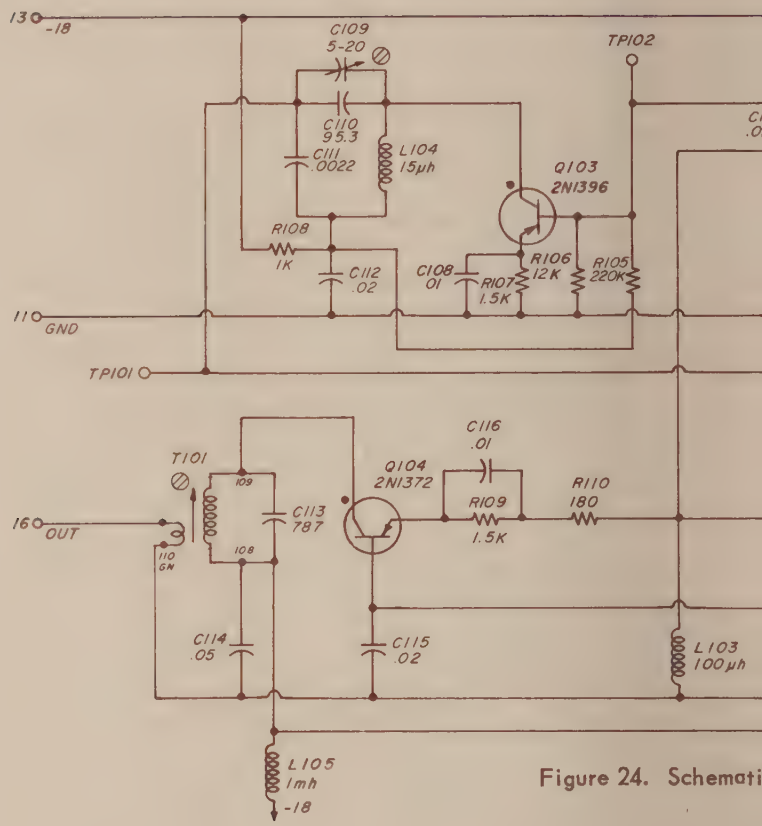
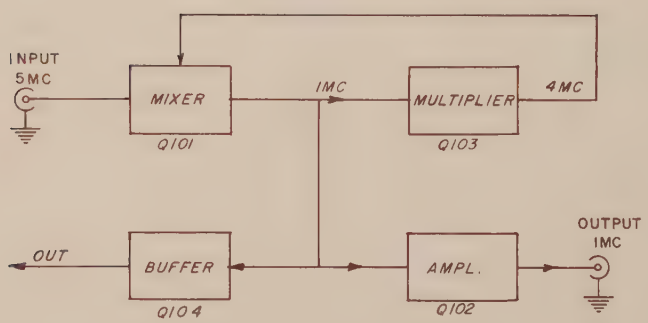
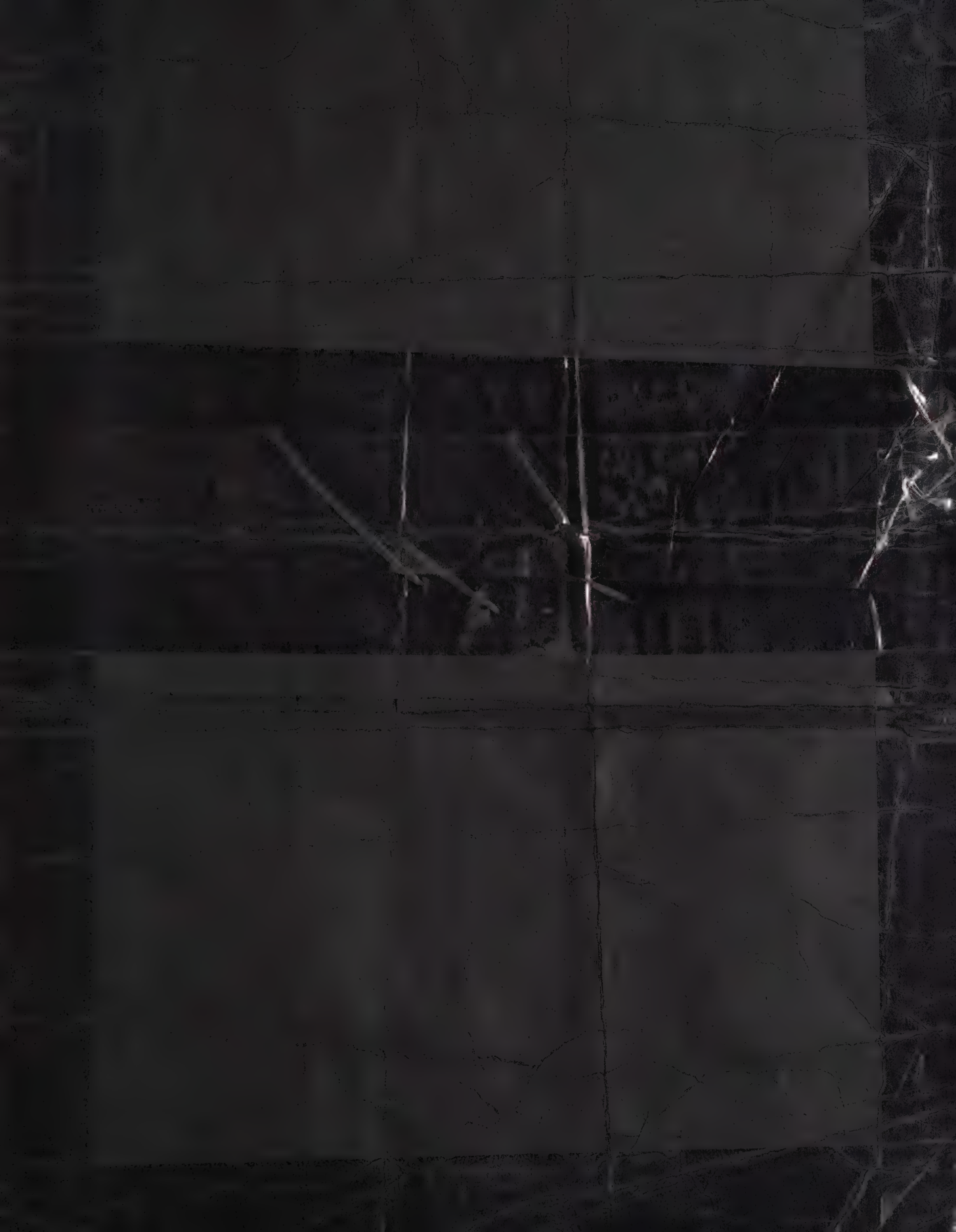
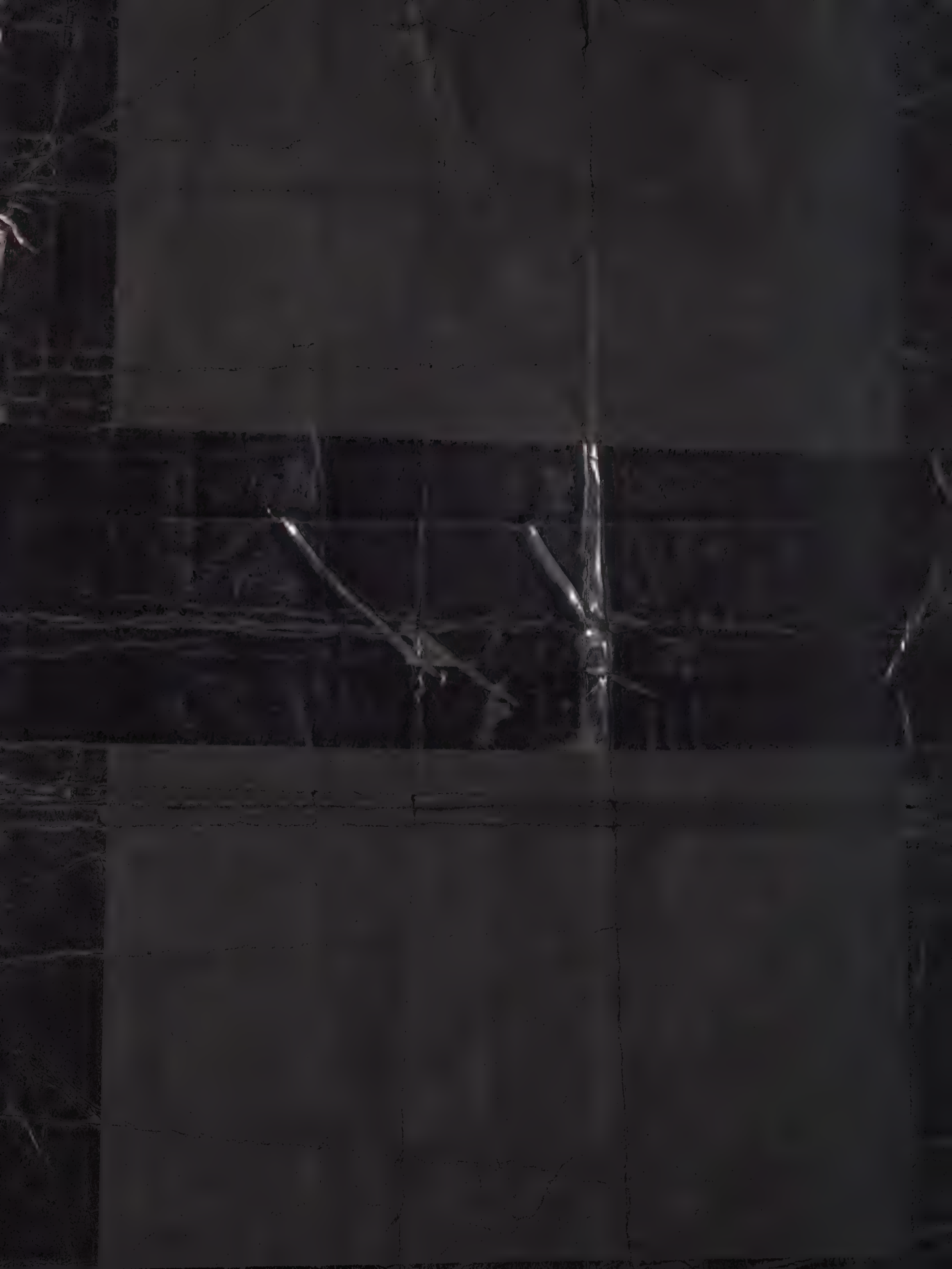


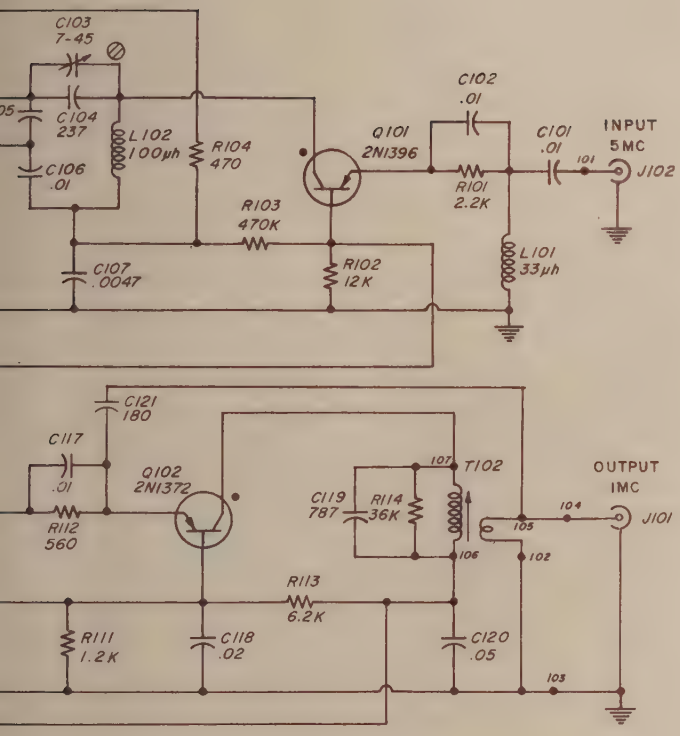
Figure 24. Schemati



Block Diagram







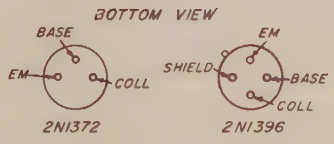
NOTES:

RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED

RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 M=1 MEGOHM

CAPACITANCE VALUES ONE & OVER IN MICROMICROFARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.

⊘ SCREWDRIVER CONTROL



Diagram, Type 1114-P1 1-Mc Plug-In Unit.

Figure 25a. Etched Board Layout, Type 1114-P2 100-KC Plug-In Unit.

PARTS LIST

TYPE 1114-P2 100-KC PLUG-IN UNIT

RESISTORS				PART NO. (NOTE A)
R201	6.8 k	±5%	1/2 w	REC-20BF(682B)
R202	470	±5%	1/2 w	REC-20BF(471B)
R203	1 k	±5%	1/2 w	REC-20BF(102B)
R204	750	±5%	1/2 w	REC-20BF(751B)
R205	820	±5%	1/2 w	REC-20BF(821B)
R206	2.74 k	±1%	1/8 w	REF-60(2741A)
R207	2.74 k	±1%	1/8 w	REF-60(2741A)
R208	10 k	±20%		POSC-22
R209	31.6 k	±1%	1/8 w	REF-60(3161A)
R210	820	±5%	1/2 w	REC-20BF(821B)
R211	3.9 k	±5%	1/2 w	REC-20BF(392B)
R212	18 k	±5%	1/2 w	REC-20BF(183B)
R213	12 k	±5%	1/2 w	REC-20BF(123B)
R214	2 k	±5%	1/2 w	REC-20BF(202B)
R215	18 k	±5%	1/2 w	REC-20BF(183B)
R216	12 k	±5%	1/2 w	REC-20BF(123B)
R217	3.9 k	±5%	1/2 w	REC-20BF(392B)
R219	10 k	±5%	1/2 w	REC-20BF(103B)
R220	6.2 k	±5%	1/2 w	REC-20BF(622B)
R221	10 k	±5%	1/2 w	REC-20BF(103B)
R222	3.3 k	±5%	1/2 w	REC-20BF(332B)
R223	56	±5%	1/2 w	REC-20BF(560B)
R224	820	±5%	1/2 w	REC-20BF(821B)
R225	2.4 k	±5%	1/2 w	REC-20BF(242B)
R226	13 k	±5%	1/2 w	REC-20BF(133B)
R227	150	±5%	1/2 w	REC-20BF(151B)
R228	3.3 k	±5%	1/2 w	REC-20BF(332B)
R229	3.3 k	±5%	1/2 w	REC-20BF(332B)
R230	3.3 k	±5%	1/2 w	REC-20BF(332B)

CAPACITORS				PART NO. (NOTE A)
C201	100 pf	±10%NM	500 dcwv	COC-21(101C)
C202	330 pf	±10%NM	500 dcwv	COC-21(331C)
C203	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)

CAPACITORS				PART NO. (NOTE A)
C204	383 pf	±2%	500 dcwv	COM-5E(3830A1)
C205	220 pf	±10%NM	500 dcwv	COC-21(221C)
C206	100 pf	±10%NM	500 dcwv	COC-21(101C)
C207	100 pf	±10%NM	500 dcwv	COC-21(101C)
C208	0.01 µf	±1%	500 dcwv	COM-1F(103A)
C209	0.1 µf	+80-20%	50 dcwv	COC-63-3(104D)
C210	0.1 µf	+80-20%	50 dcwv	COC-63-3(104D)
C211	0.1 µf	+80-20%	50 dcwv	COC-63-3(104D)
C212	0.01 µf	±1%	500 dcwv	COM-1F(103A)
C213	0.1 µf	+80-20%	50 dcwv	COC-63-3(104D)
C214	470 pf	±20%	500 dcwv	COC-60(471D)

MISCELLANEOUS		
D201	Diode	1N118
D202	Diode	1N625
D203	Diode	1N118
D204	Diode	1N118
D205	Diode	1N118
J201	Connector, Coaxial	874-4501
J202	Connector, Coaxial	874-4501
J203	Connector, Coaxial	874-4501
L201	Choke, 150 µh	CHM-4(151)
L202	Choke, 39 µh	CHM-2(390)
L203	Inductor, 250 µh	1114-P2-200
Q201	Transistor	2N645
Q202	Transistor	2N582
Q203	Transistor	2N582
Q204	Transistor	2N582
Q205	Transistor	2N582
Q206	Transistor	2N169A
Q207	Transistor	2N1372
Q208	Transistor	2N169A
T201	Transformer	1114-P2-202

For notes, see page 21.

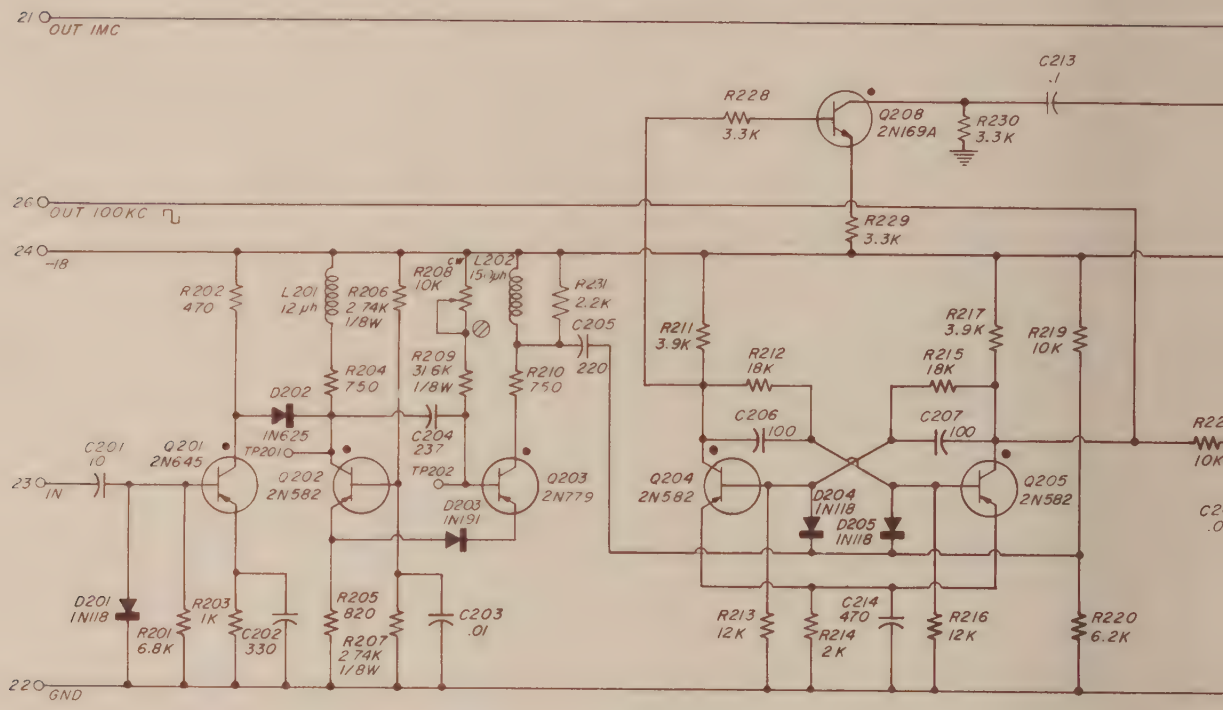


Figure 25. Schematic Diagram, Type 1114-P2 100-KC P

NOTES

RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED

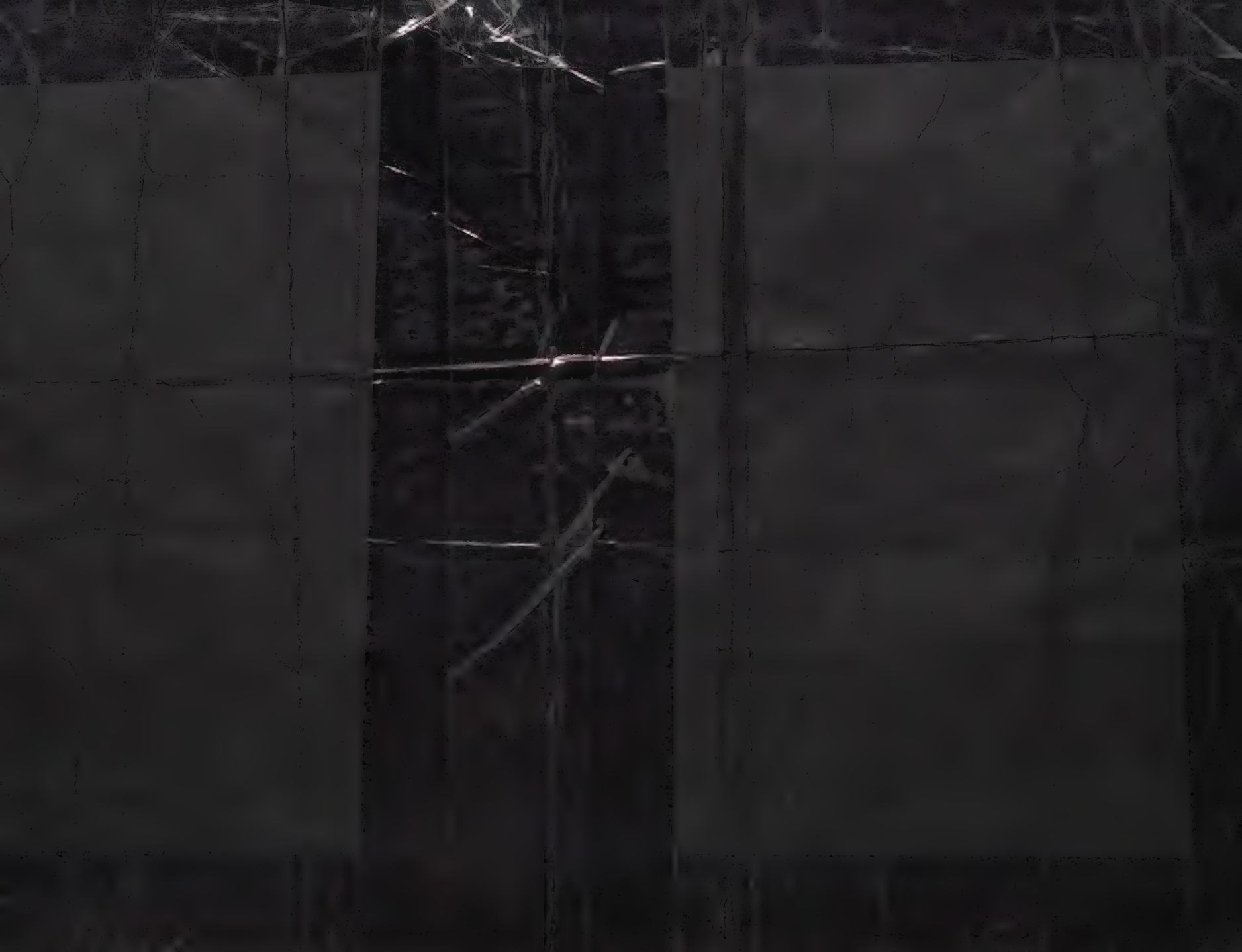
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED

K = 1000 OHMS M = 1 MEGOHM

CAPACITANCE VALUES ONE & OVER IN MICRO-MICRO-FARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED

⊘ SCREWDRIVER CONTROL

Block Diagram



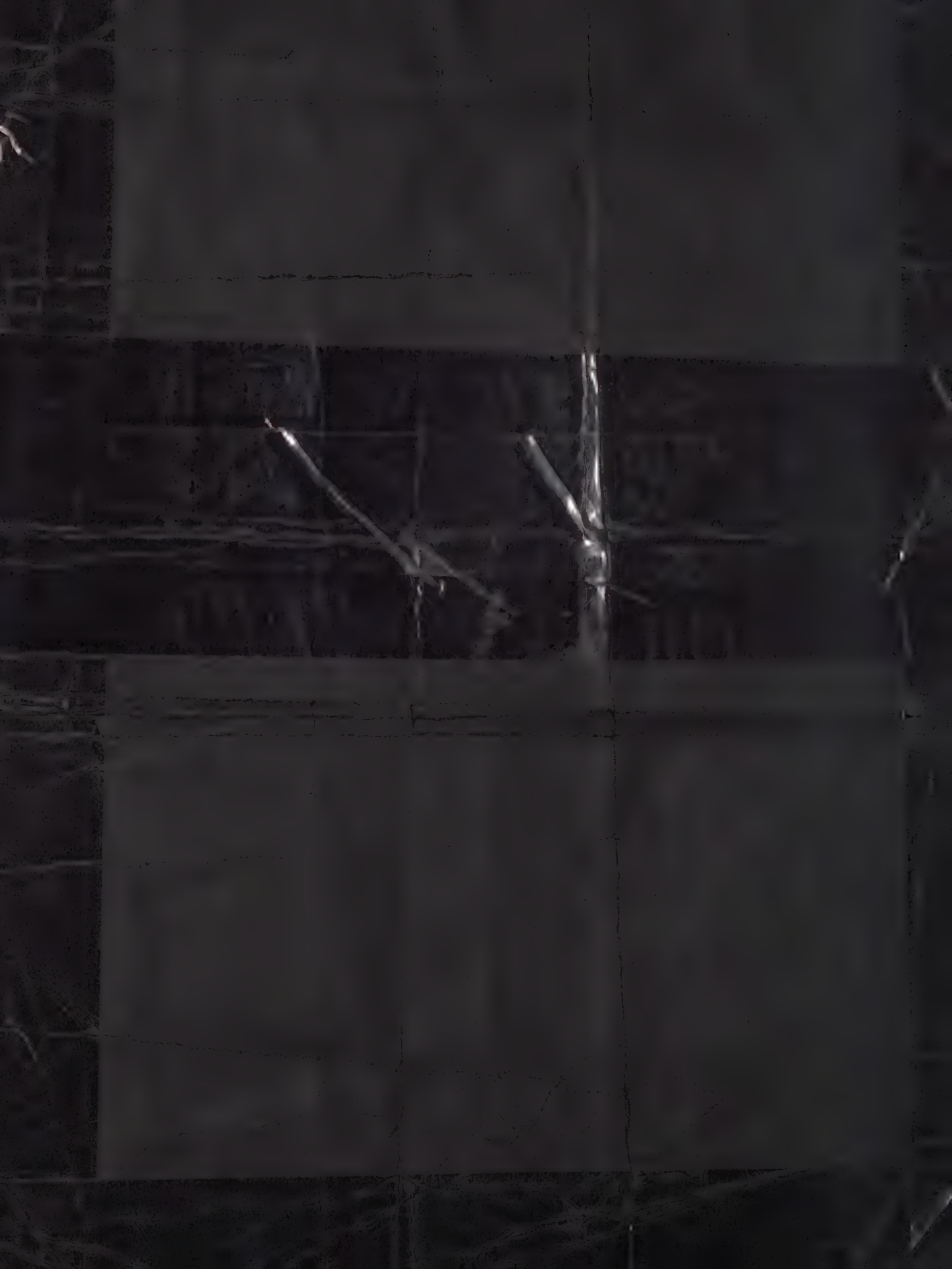
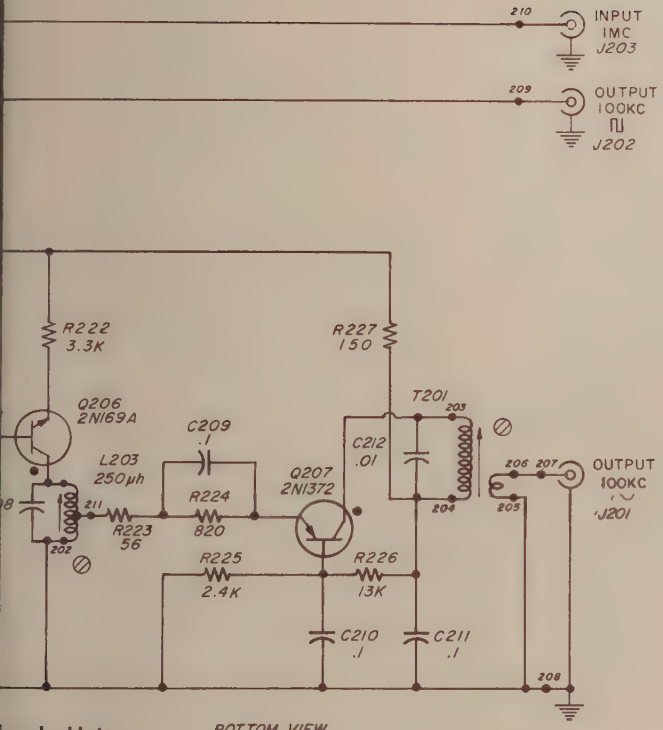
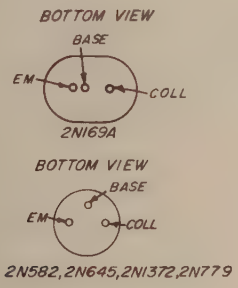


Figure 25. Schematic Diagram, Type 1114-P2 100-KC Plug-In Unit



lug-In Unit



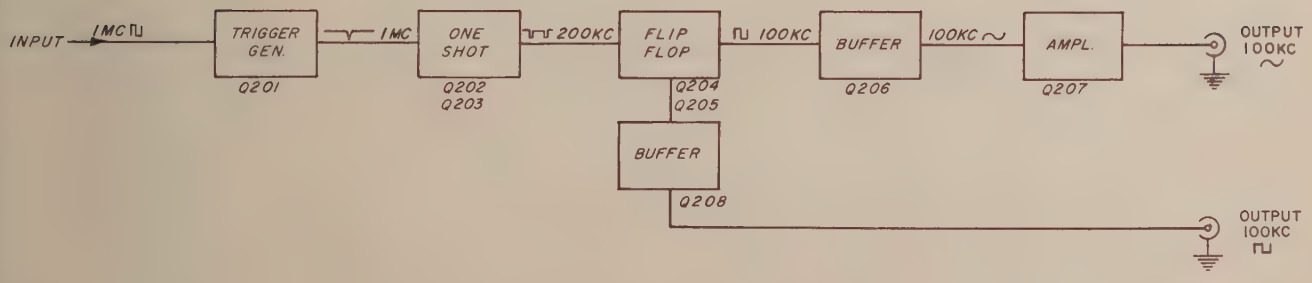


Figure 26a. Etched Board Layout, Type 1114-P3 10-KC Plug-In Unit.

PARTS LIST

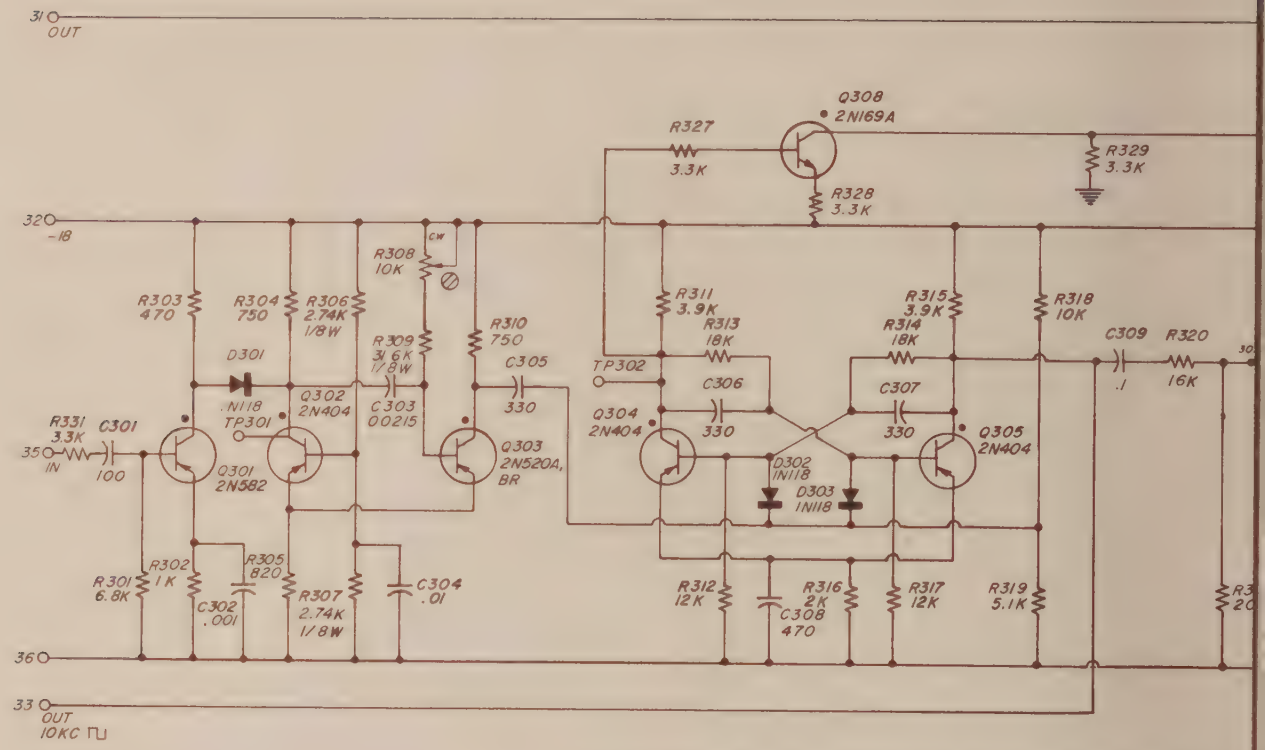
TYPE 1114-P3 10-KC PLUG-IN UNIT

RESISTORS				PART NO. (NOTE A)
R301	6.8 k	±5%	1/2 w	REC-20BF(682B)
R302	1 k	±5%	1/2 w	REC-20BF(102B)
R303	470	±5%	1/2 w	REC-20BF(471B)
R304	750	±5%	1/2 w	REC-20BF(751B)
R305	820	±5%	1/2 w	REC-20BF(821B)
R306	2.74 k	±1%	1/8 w	REF-60(2741A)
R307	2.74 k	±1%	1/8 w	REF-60(2741A)
R308	10 k	±20%		POSC-22(103)
R309	31.6 k	±1%	1/8 w	REF-60(3162A)
R310	750	±5%	1/2 w	REC-20BF(751B)
R311	3.9 k	±5%	1/2 w	REC-20BF(392B)
R312	12 k	±5%	1/2 w	REC-20BF(123B)
R313	18 k	±5%	1/2 w	REC-20BF(183B)
R314	18 k	±5%	1/2 w	REC-20BF(183B)
R315	3.9 k	±5%	1/2 w	REC-20BF(392B)
R316	2 k	±5%	1/2 w	REC-20BF(202B)
R317	12 k	±5%	1/2 w	REC-20BF(123B)
R318	10 k	±5%	1/2 w	REC-20BF(103B)
R319	5.1 k	±5%	1/2 w	REC-20BF(512B)
R320	16 k	±5%	1/2 w	REC-20BF(163B)
R321	20 k	±5%	1/2 w	REC-20BF(203B)
R322	10 k	±5%	1/2 w	REC-20BF(103B)
R323	10 k	±5%	1/2 w	REC-20BF(103B)
R324	620	±5%	1/2 w	REC-20BF(621B)
R325	620	±5%	1/2 w	REC-20BF(621B)
R326	33 k	±5%	1/2 w	REC-20BF(333B)
R327	3.3 k	±5%	1/2 w	REC-20BF(332B)
R328	3.3 k	±5%	1/2 w	REC-20BF(332B)
R329	3.3 k	±5%	1/2 w	REC-20BF(332B)
R330	15 k	±5%	1/2 w	REC-20BF(153B)
R331	3.3 k	±5%	1/2 w	REC-20BF(332B)

CAPACITORS				PART NO. (NOTE A)
C301	100 pf	±10%NM	500 dcwv	COC-21(101C)
C302	0.001 µf	±10%	500 dcwv	COM-5B(102C)
C303	0.00215 µf	±2%	500 dcwv	COM-5E(2151A1)
C304	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C305	330 pf	±10%NM	500 dcwv	COC-21(331C)
C306	330 pf	±10%NM	500 dcwv	COC-21(331C)
C307	330 pf	±10%NM	500 dcwv	COC-21(331C)
C308	470 pf	±20%	500 dcwv	COC-60(471D)
C309	0.1 µf	+80-20%	50 dcwv	COC-63-3(104D)
C310	0.47 µf	±20%	35 dcwv	COE-60(474D)
C311	0.47 µf	±20%	35 dcwv	COE-60(474D)
C312	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C313	0.0047 µf	±20%	500 dcwv	COC-62(472D)

MISCELLANEOUS		
D301	Diode	1N118
D302	Diode	1N118
D303	Diode	1N118
J301	Connector, Coaxial	874-4501
J302	Connector, Coaxial	874-4501
J303	Connector, Coaxial	874-4501
LC301	Filter	1114-41-3
Q301	Transistor	2N582
Q302	Transistor	2N404
Q303	Transistor	2N520A,BR
Q304	Transistor	2N404
Q305	Transistor	2N404
Q306	Transistor	2N1374
Q307	Transistor	2N1374
Q308	Transistor	2N169A

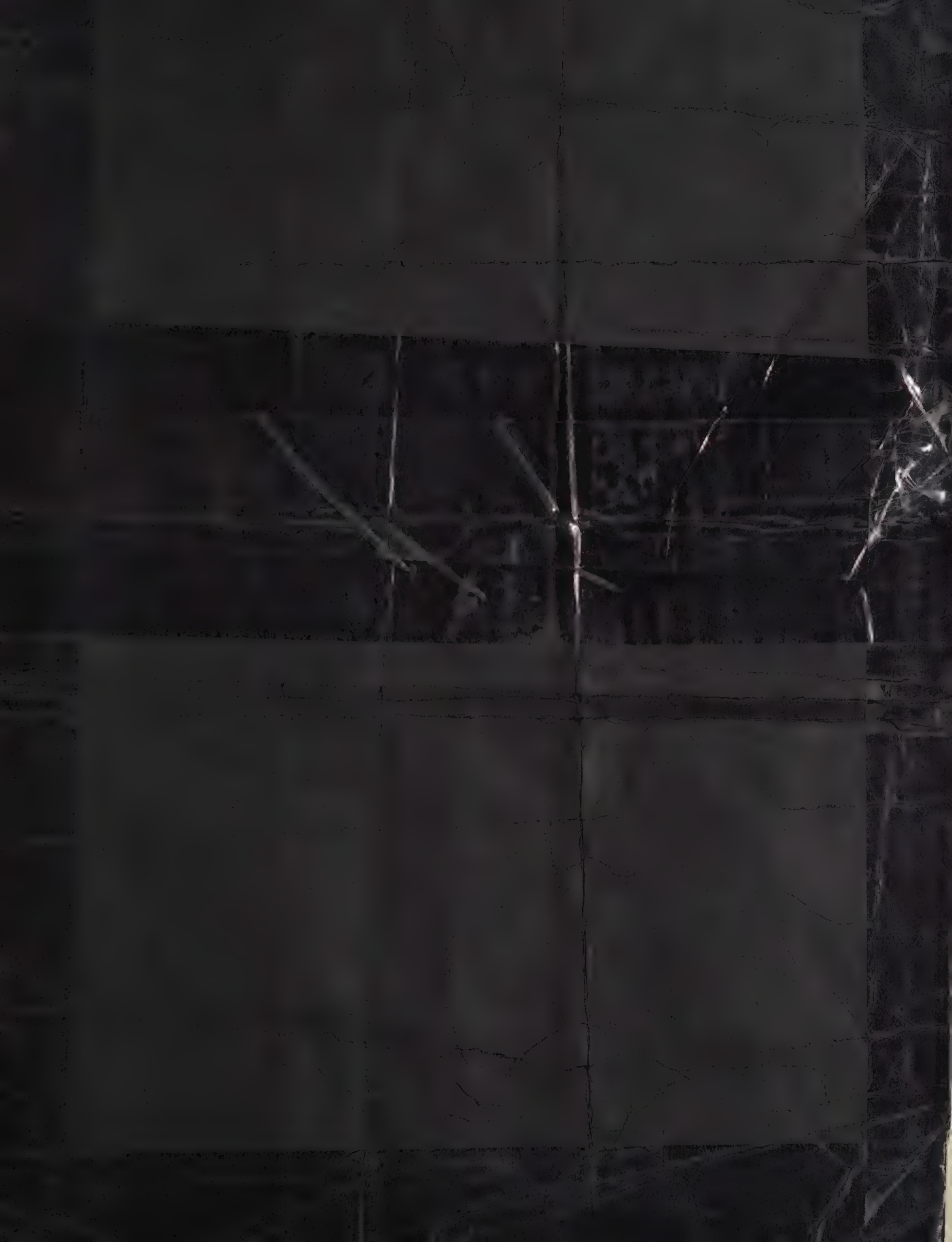
For notes, see page 21.

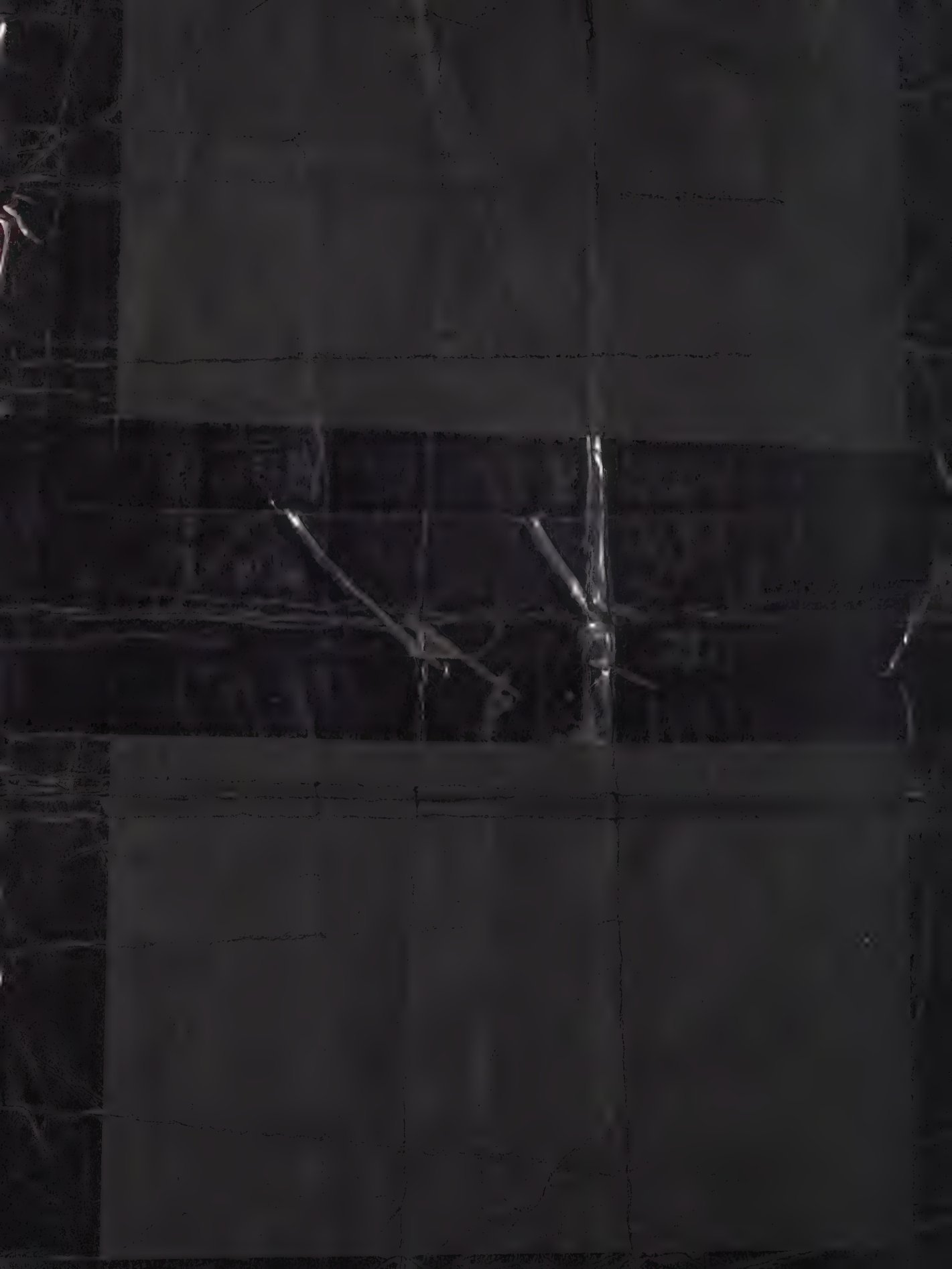


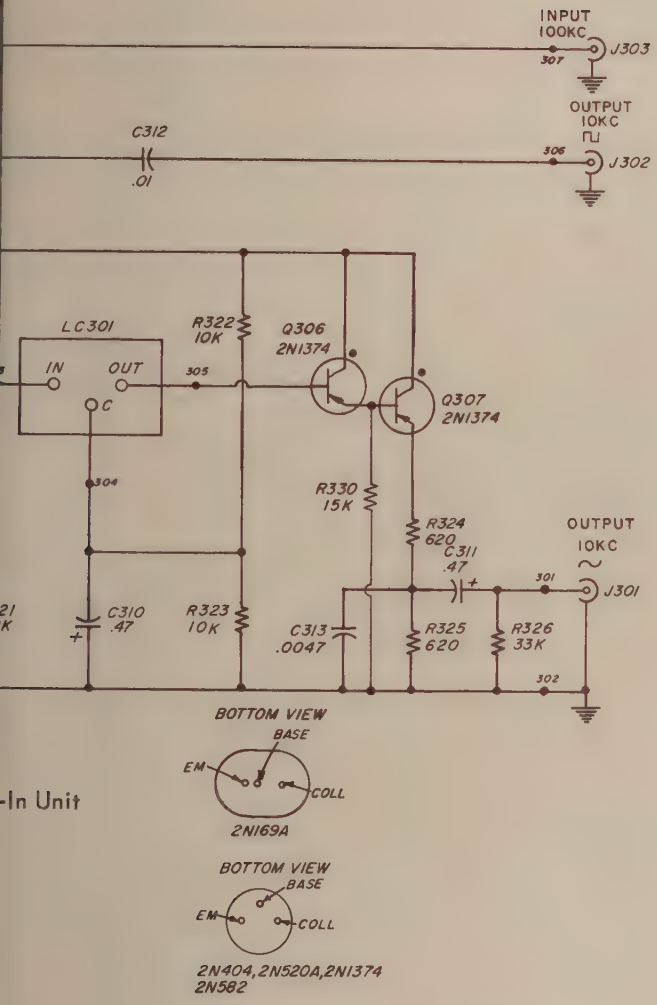
NOTES:
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 OHMS M=1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN MICRO-MICROFARADS LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
⊘ SCREWDRIVER CONTROL

Figure 26. Schematic Diagram, Type 1114-P3 10-KC Plug

Block Diagram






INPUT
100KC
J303
307
OUTPUT
10KC
C312
.01
306
J302
LC301
IN
OUT
C
305
R322
10K
Q306
2N1374
Q307
2N1374
304
R330
15K
R324
620
C311
.47
OUTPUT
10KC
301
J301
C310
.47
R323
10K
C313
.0047
R325
620
R326
33K
302
BOTTOM VIEW
BASE
EM
COLL
2N169A
BOTTOM VIEW
BASE
EM
COLL
2N404,2N520A,2N1374
2N582

-In Unit

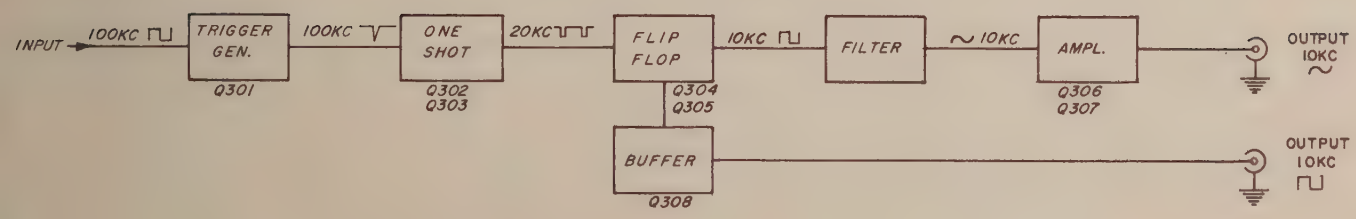

INPUT
100KC
TRIGGER GEN.
Q301
100KC
ONE SHOT
Q302
Q303
20KC
FLIP FLOP
Q304
Q305
10KC
FILTER
~10KC
AMPL.
Q306
Q307
OUTPUT
10KC
BUFFER
Q308
OUTPUT
10KC

Figure 27a. Etched Board Layout, Type 1114-P4 1-KC Plug-In Unit.

PARTS LIST

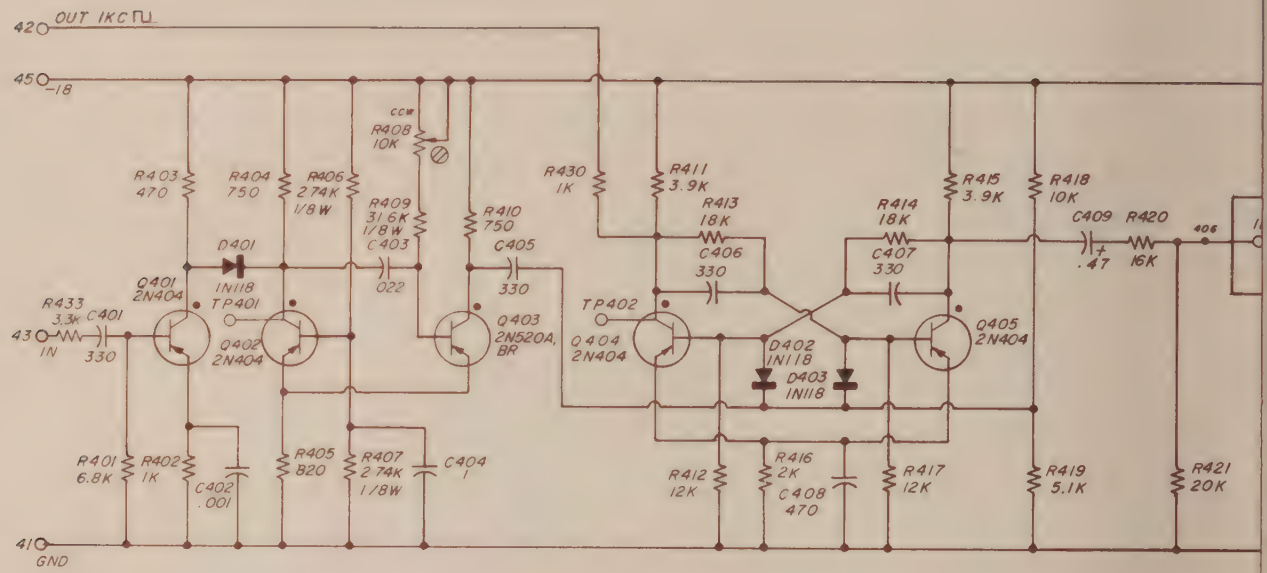
TYPE 1114-P4 1-KC PLUG-IN UNIT

RESISTORS				PART NO. (NOTE A)
R401	6.8 k	±5%	1/2 w	REC-20BF(682B)
R402	1 k	±5%	1/2 w	REC-20BF(102B)
R403	470	±5%	1/2 w	REC-20BF(471B)
R404	750	±5%	1/2 w	REC-20BF(751B)
R405	820	±5%	1/2 w	REC-20BF(821B)
R406	2.74 k	±1%	1/8 w	REF-60(2741A)
R407	2.74 k	±1%	1/8 w	REF-60(2741A)
R408	10 k	±20%		POSC-22(103)
R409	31.6 k	±1%	1/8 w	REF-60(3162A)
R410	750	±5%	1/2 w	REC-20BF(751B)
R411	3.9 k	±5%	1/2 w	REC-20BF(392B)
R412	12 k	±5%	1/2 w	REC-20BF(123B)
R413	18 k	±5%	1/2 w	REC-20BF(183B)
R414	18 k	±5%	1/2 w	REC-20BF(183B)
R415	3.9 k	±5%	1/2 w	REC-20BF(392B)
R416	2 k	±5%	1/2 w	REC-20BF(202B)
R417	12 k	±5%	1/2 w	REC-20BF(123B)
R418	10 k	±5%	1/2 w	REC-20BF(103B)
R419	5.1 k	±5%	1/2 w	REC-20BF(512B)
R420	16 k	±5%	1/2 w	REC-20BF(163B)
R421	20 k	±5%	1/2 w	REC-20BF(203B)
R422	10 k	±5%	1/2 w	REC-20BF(103B)
R423	10 k	±5%	1/2 w	REC-20BF(103B)
R424	620	±5%	1/2 w	REC-20BF(621B)
R425	620	±5%	1/2 w	REC-20BF(621B)
R426	620	±5%	1/2 w	REC-20BF(621B)
R427	620	±5%	1/2 w	REC-20BF(621B)
R428	33 k	±5%	1/2 w	REC-20BF(333B)
R429	33 k	±5%	1/2 w	REC-20BF(333B)
R430	1 k	±5%	1/2 w	REC-20BF(102B)
R431	15 k	±5%	1/2 w	REC-20BF(153B)
R432	15 k	±5%	1/2 w	REC-20BF(153B)
R433	3.3 k	±5%	1/2 w	REC-20BF(332B)

CAPACITORS				PART NO. (NOTE A)
C401	330 pf	±10% NM	500 dcwv	COC-21(331C)
C402	0.001 µf	±10%	500 dcwv	COM-5B(102C)
C403	0.022 µf	±2%	100 dcwv	COP-24(223A1)
C404	0.1 µf	+80-20%	50 dcwv	COC-63-3(104D)
C405	330 pf	±10% NM	500 dcwv	COC-21(331C)
C406	330 pf	±10% NM	500 dcwv	COC-21(331C)
C407	330 pf	±10% NM	500 dcwv	COC-21(331C)
C408	470 pf	±20%	500 dcwv	COC-60(471D)
C409	0.47 µf	±20%	35 dcwv	COE-60(474D)
C410	5 µf		50 dcwv	COE-57
C411	5 µf		50 dcwv	COE-57
C412	5 µf		50 dcwv	COE-57

MISCELLANEOUS		
D401	Diode	1N118
D402	Diode	1N118
D403	Diode	1N118
J401	Connector, Coaxial	874-4501
J402	Connector, Coaxial	874-4501
LC401	Filter	1114-41-4
Q401	Transistor	2N404
Q402	Transistor	2N404
Q403	Transistor	2N520A, BR
Q404	Transistor	2N404
Q405	Transistor	2N404
Q406	Transistor	2N1374
Q407	Transistor	2N1374
Q408	Transistor	2N1374
Q409	Transistor	2N1374

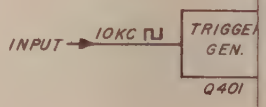
For notes, see page 21.



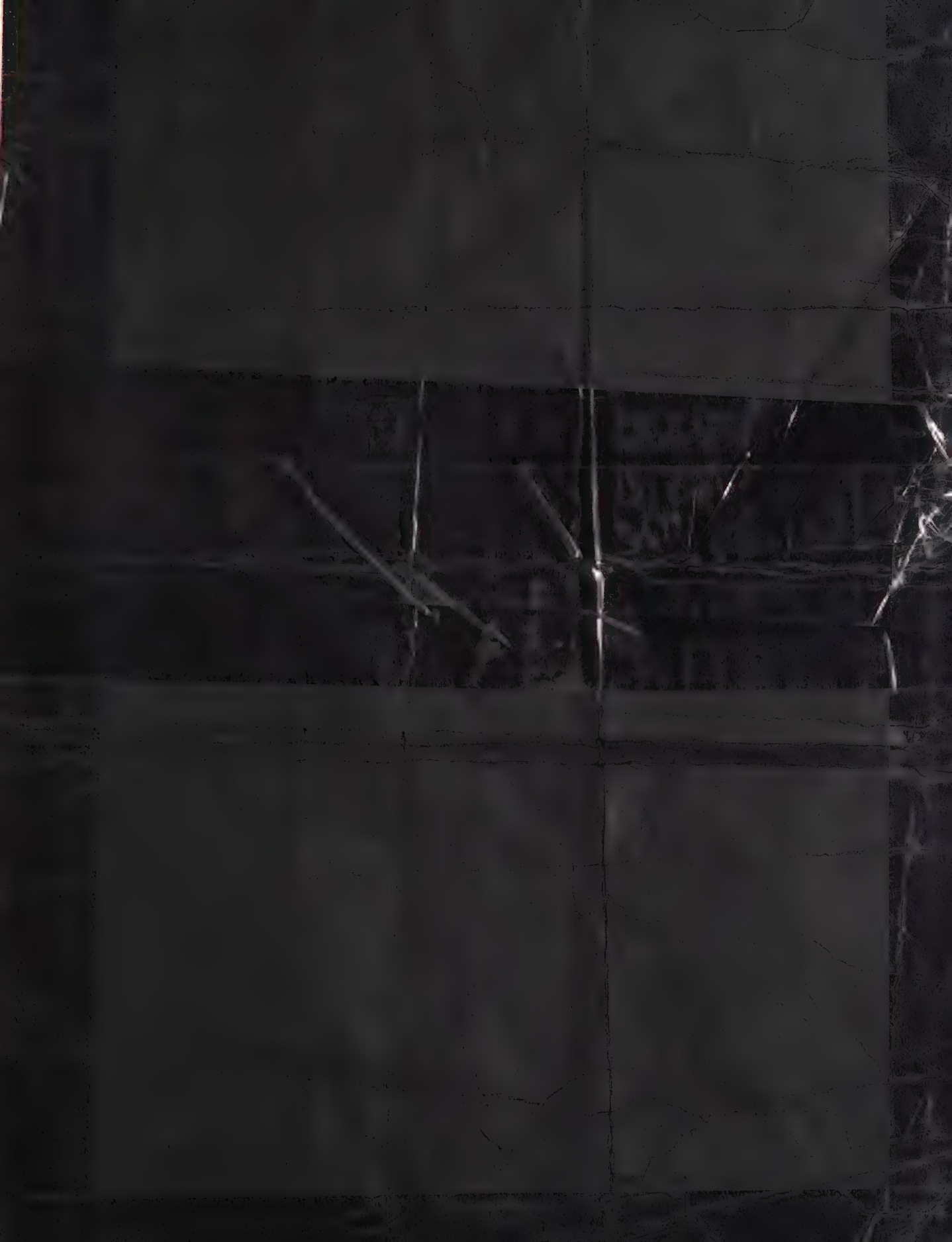
NOTES:

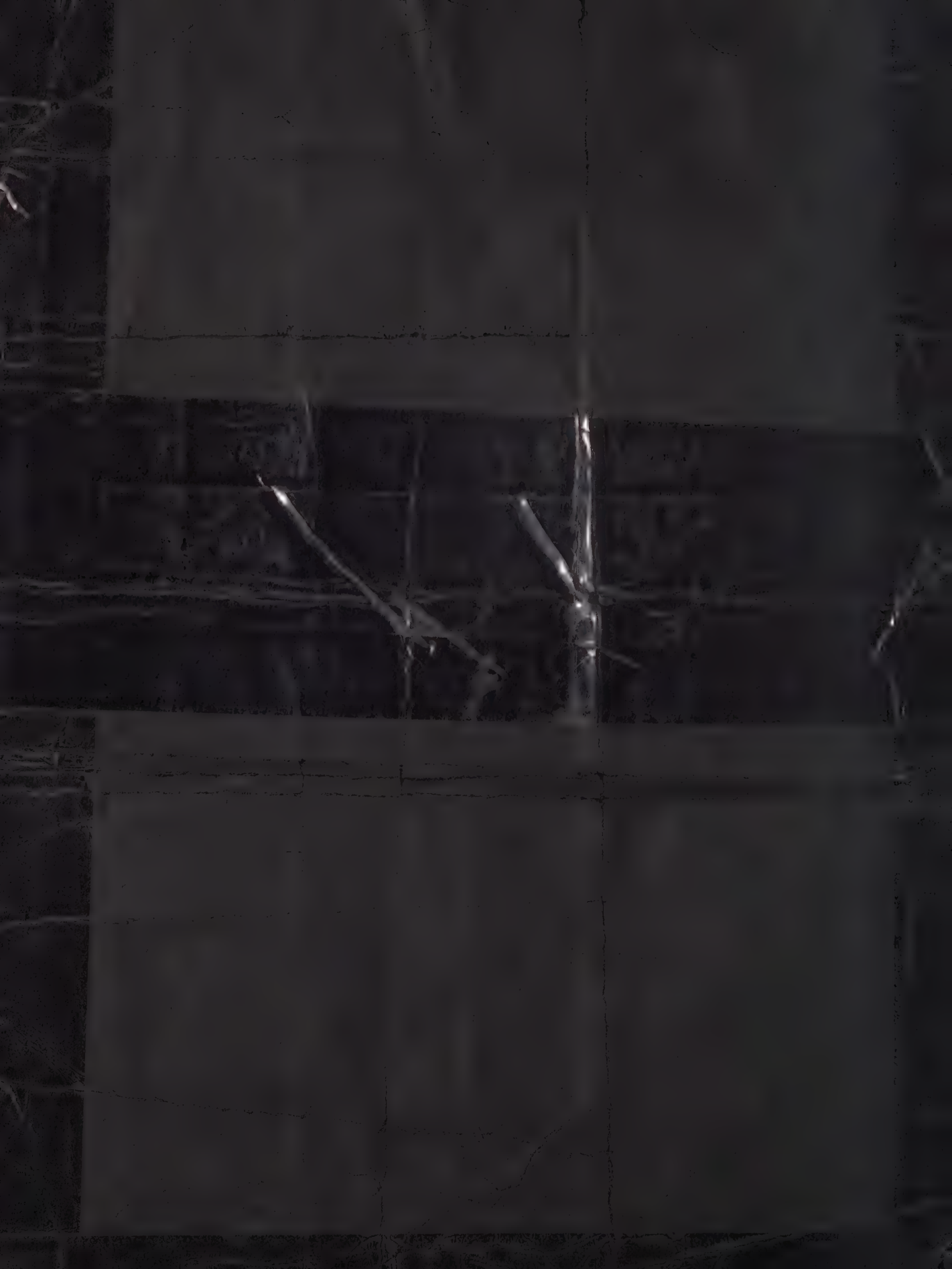
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K = 1000 OHMS M = 1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN MICRO-MICRO-FARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
⊘ SCREWDRIVER CONTROL

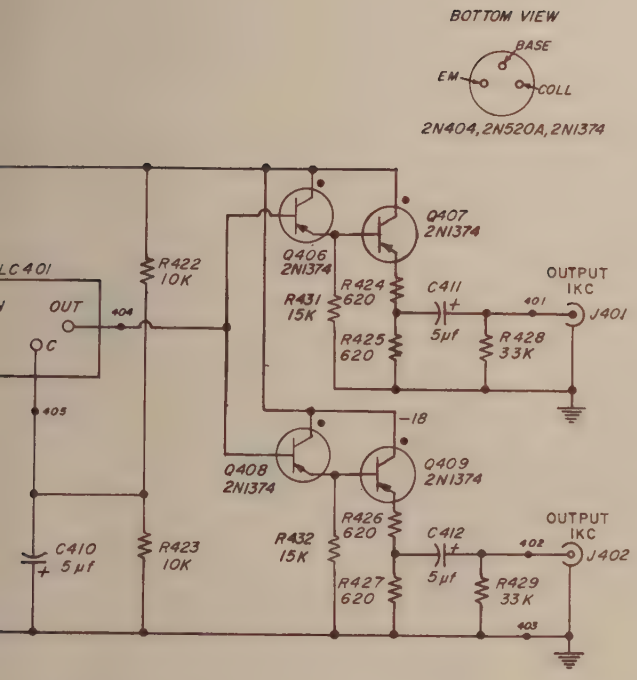
Figure 27. Schematic Diagram, Type 1114-P



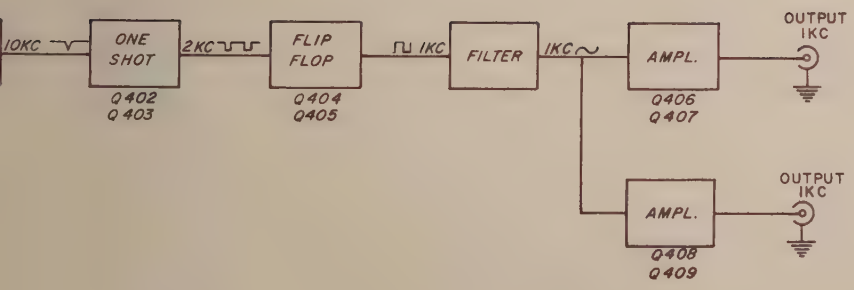
Block Diagram







1-KC Plug-In Unit



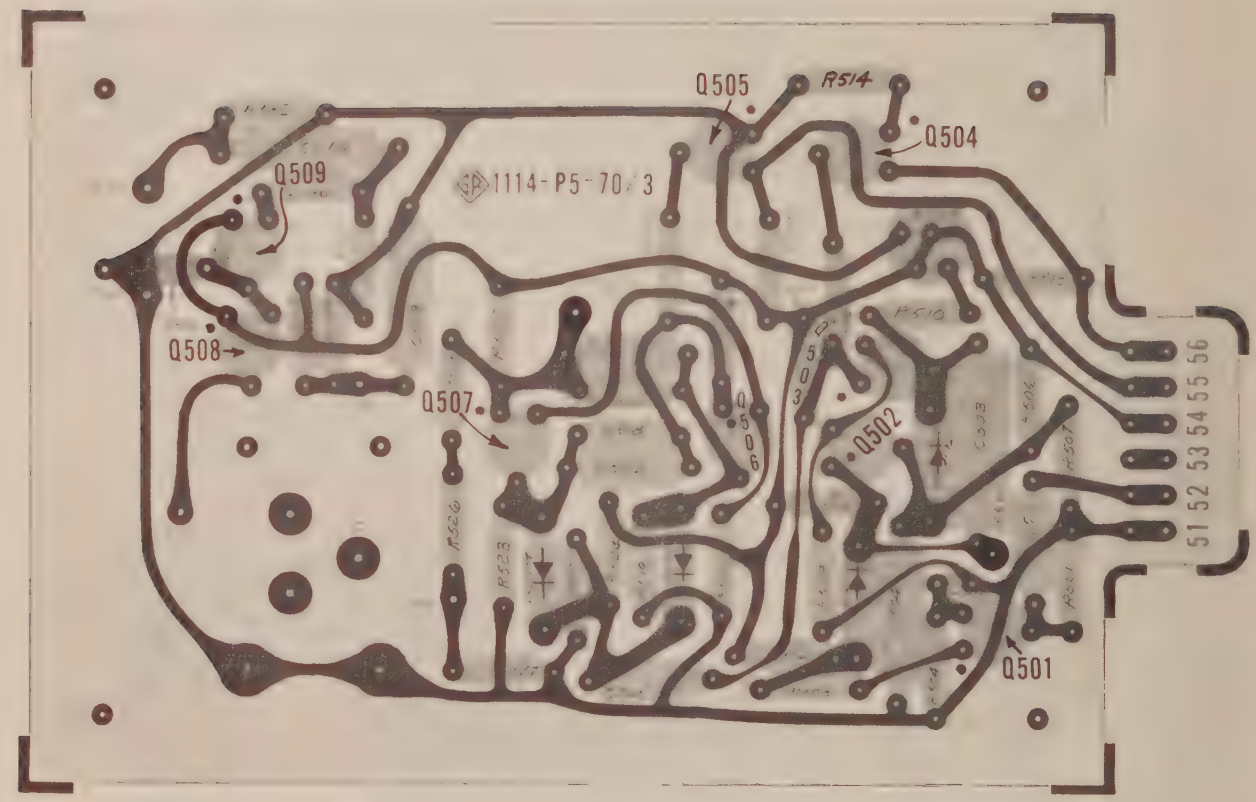


Figure 28a. Etched Board Layout, Type 1114-P5 100-CPS Plug-In Unit.

PARTS LIST

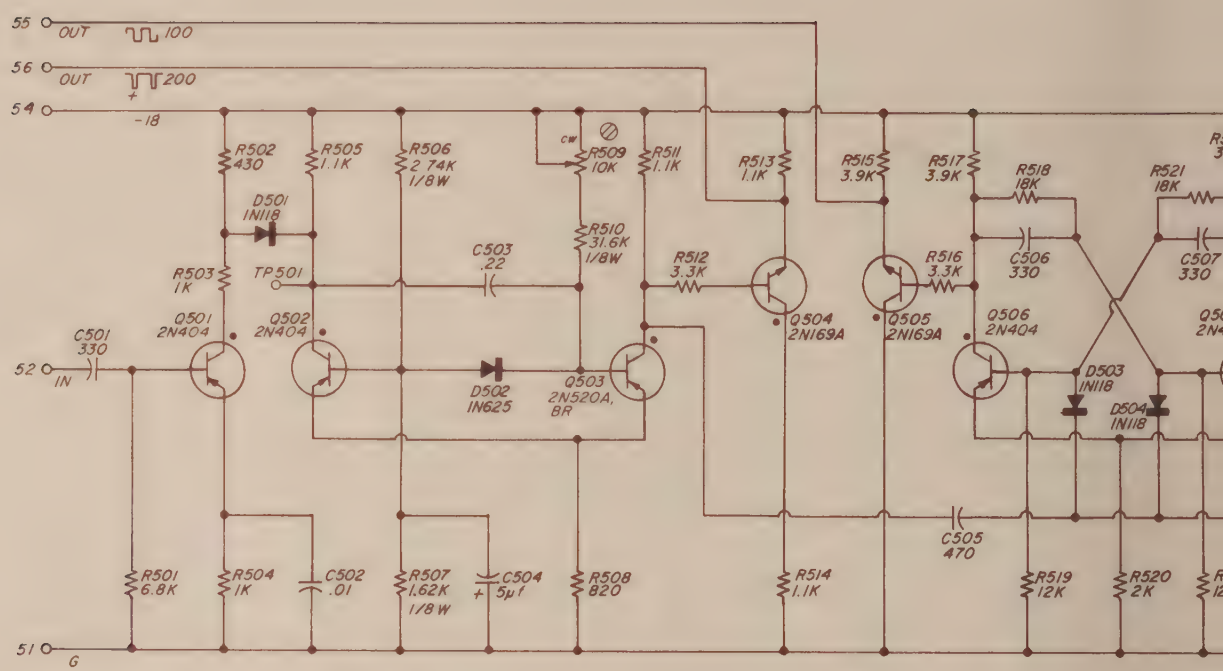
TYPE 1114-P5 100-CPS PLUG-IN UNIT

RESISTORS				PART NO. (NOTE A)
R501	6.8k	±5%	1/2 w	REC-20BF(682B)
R502	430	±5%	1/2 w	REC-20BF(431B)
R503	1k	±5%	1/2 w	REC-20BF(102B)
R504	1k	±5%	1/2 w	REC-20BF(102B)
R505	1.1k	±5%	1/2 w	REC-20BF(112B)
R506	2.74k	±1%	1/8 w	REF-70(2741A)
R507	1.62k	±1%	1/8 w	REF-70(1621A)
R508	820	±5%	1/2 w	REC-20BF(821B)
R509	10k	±20%		POSC-22(103)
R510	31.6k	±1%	1/8 w	REF-60(3162A)
R511	1.1k	±5%	1/2 w	REC-20BF(112B)
R512	3.3k	±5%	1/2 w	REC-20BF(332B)
R513	1.1k	±5%	1/2 w	REC-20BF(112B)
R514	1.1k	±5%	1/2 w	REC-20BF(112B)
R515	3.9k	±5%	1/2 w	REC-20BF(392B)
R516	3.3k	±5%	1/2 w	REC-20BF(332B)
R517	3.9k	±5%	1/2 w	REC-20BF(392B)
R518	18k	±5%	1/2 w	REC-20BF(183B)
R519	12k	±5%	1/2 w	REC-20BF(123B)
R520	2k	±5%	1/2 w	REC-20BF(202B)
R521	18k	±5%	1/2 w	REC-20BF(183B)
R522	3.9k	±5%	1/2 w	REC-20BF(392B)
R523	12k	±5%	1/2 w	REC-20BF(123B)
R524	10k	±5%	1/2 w	REC-20BF(103B)
R525	6.2k	±5%	1/2 w	REC-20BF(622B)
R526	16k	±5%	1/2 w	REC-20BF(163B)
R527	20k	±5%	1/2 w	REC-20BF(203B)
R528	10k	±5%	1/2 w	REC-20BF(103B)
R529	10k	±5%	1/2 w	REC-20BF(103B)
R530	620	±5%	1/2 w	REC-20BF(621B)
R531	620	±5%	1/2 w	REC-20BF(621B)
R532	33k	±5%	1/2 w	REC-20BF(333B)
R533	15k	±5%	1/2 w	REC-20BF(153B)

CAPACITORS				PART NO. (NOTE A)
C501	330 pf	±10% NM	500 dcwv	COC-21(331C)
C502	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C503	0.22 µf	±2%	100 dcwv	COP-24(224A1)
C504	5 µf		50 dcwv	COE-57
C505	470 pf	±10%	500 dcwv	COC-21(471C)
C506	330 pf	±10%	500 dcwv	COC-21(331C)
C507	330 pf	±10%	500 dcwv	COC-21(331C)
C508	0.47 µf	±20%	35 dcwv	COE-60(474D)
C509	5 µf		50 dcwv	COE-57
C510	10 µf		25 dcwv	COE-56

MISCELLANEOUS		
D501	Diode	1N118
D502	Diode	1N625
D503	Diode	1N118
D504	Diode	1N118
J501	Connector, Coaxial	874-4501
LC501	Filter	1114-41-5
Q501	Transistor	2N404
Q502	Transistor	2N404
Q503	Transistor	2N520A, BR
Q504	Transistor	2N169A
Q505	Transistor	2N169A
Q506	Transistor	2N404
Q507	Transistor	2N404
Q508	Transistor	2N1374
Q509	Transistor	2N1374

For notes, see page 21.



RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED

RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K=1000 M=1 MEGOHM

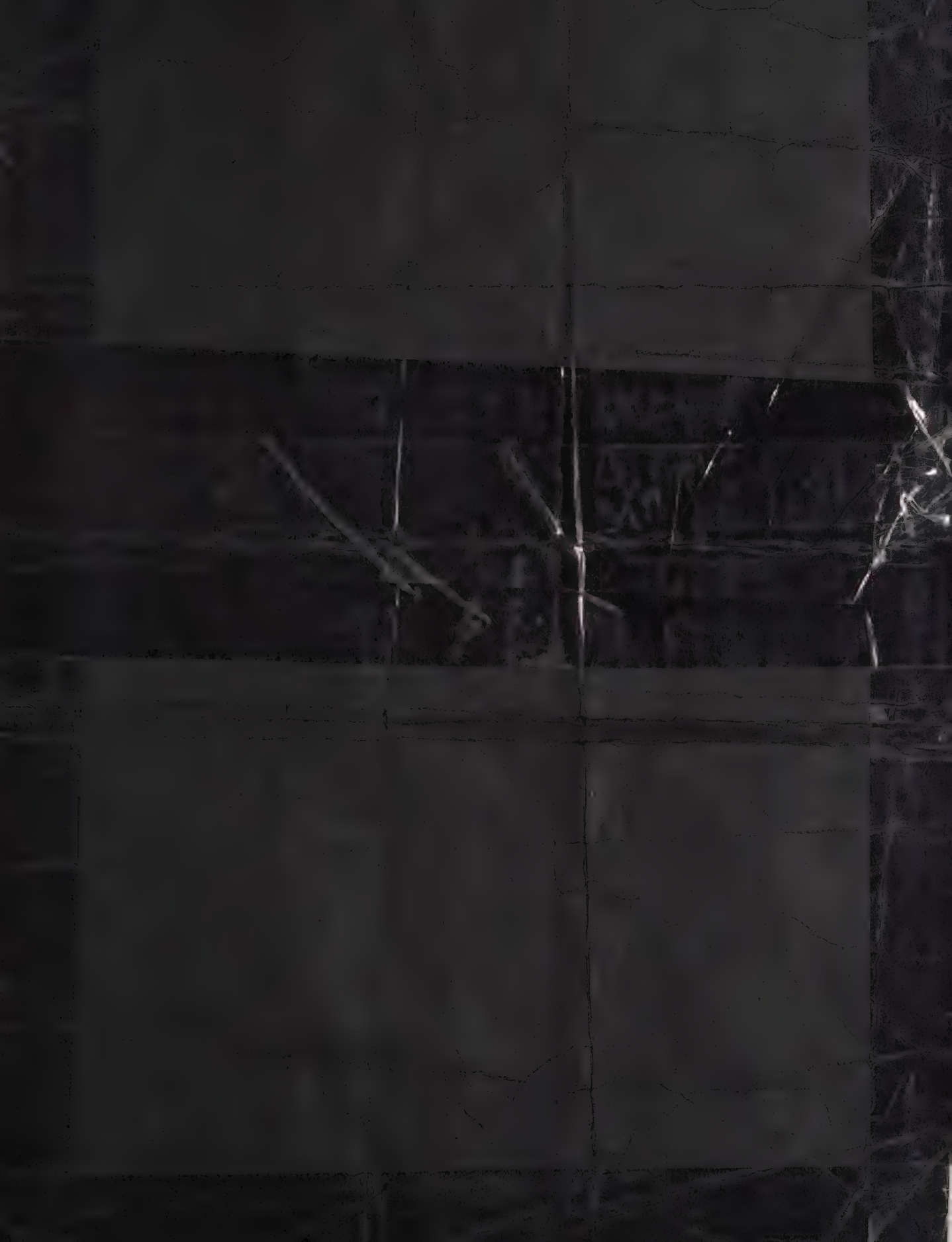
CAPACITANCE VALUES ONE AND OVER IN MICRO-MICROFARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED

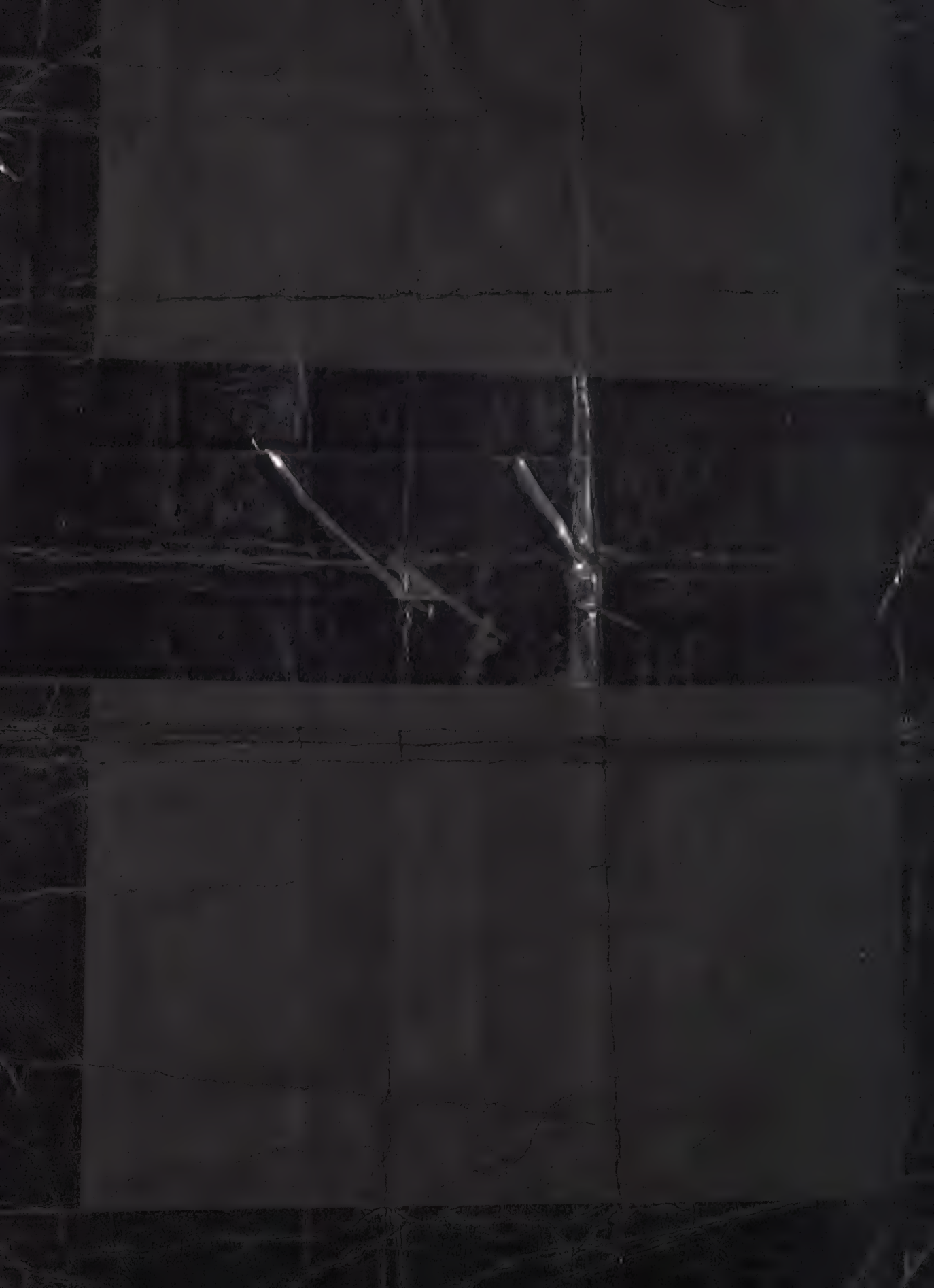
⊘ SCREWDRIVER CONTROL

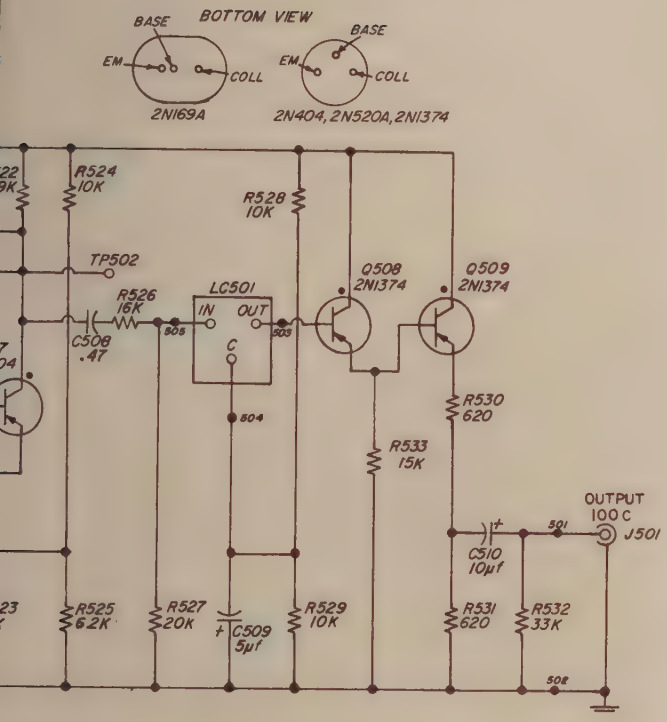
Figure 28. Sc

INPUT

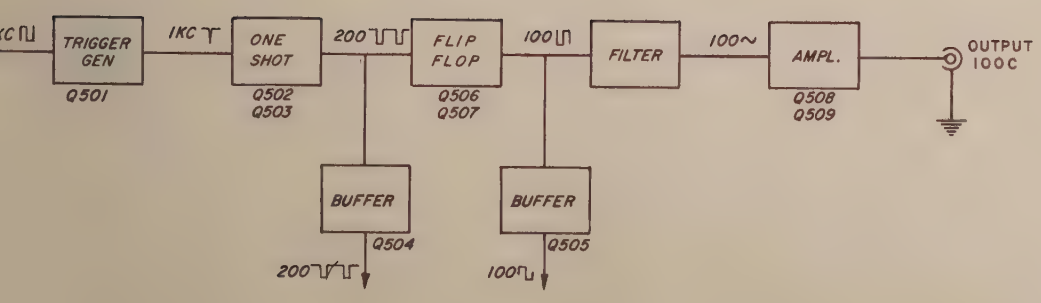
Block Diagram







ematic Diagram, Type 1114-P5 100-CPS Plug-In Unit



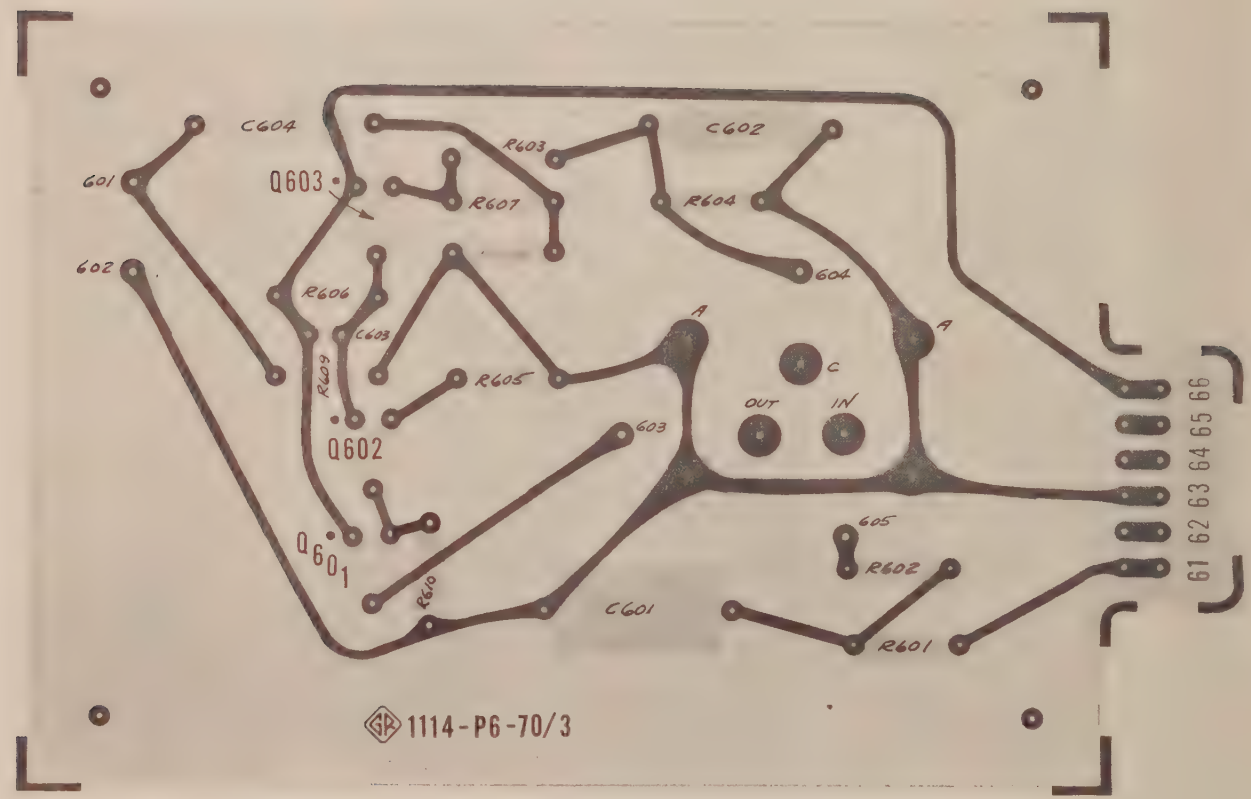


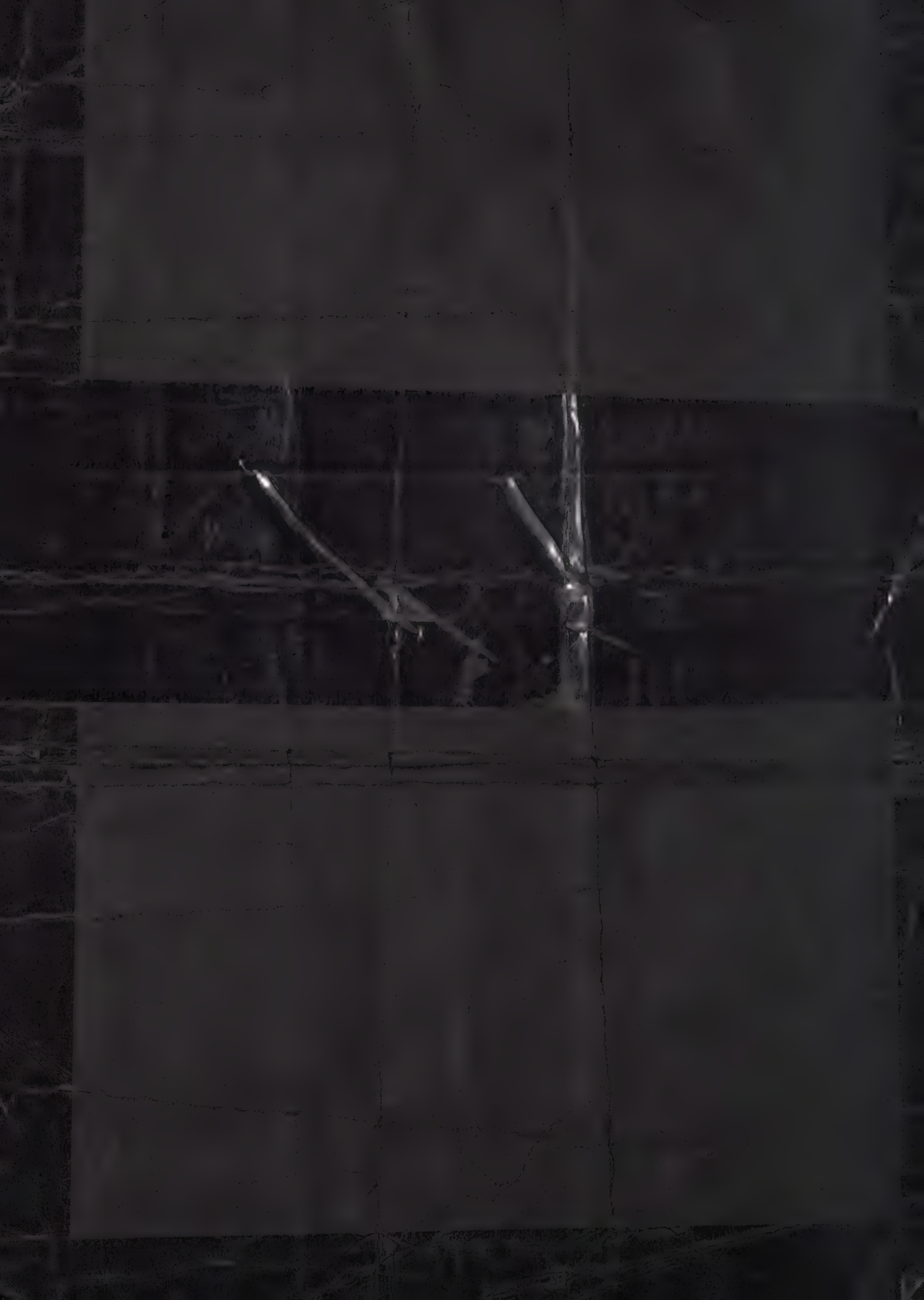
Figure 29a. Etched Board Layout, Type 1114-P6 400-CPS Plug-In Unit.

PARTS LIST

TYPE 1114-P6 400-CPS PLUG-IN UNIT

RESISTORS				PART NO. (NOTE A)
R601	13 k	±5%	1/2 w	REC-20BF(133B)
R602	8.2 k	±5%	1/2 w	REC-20BF(822B)
R603	16 k	±5%	1/2 w	REC-20BF(163B)
R604	3.6 k	±5%	1/2 w	REC-20BF(362B)
R605	1 k	±5%	1/2 w	REC-20BF(102B)
R606	7.5 k	±5%	1/2 w	REC-20BF(752B)
R607	620	±5%	1/2 w	REC-20BF(621B)
R608	1 k	±5%	1/2 w	REC-20BF(102B)
R609	33 k	±5%	1/2 w	REC-20BF(333B)
R610	15 k	±5%	1/2 w	REC-20BF(153B)
CAPACITORS				**PART NO. (NOTE A)**
C601	22 µf	±10%	1000 dcwv	COW-17(226C)
C602	5 µf		50 dcwv	COE-57
C603	0.01 µf	+80-20%	50 dcwv	COC-61-3(103D)
C604	5 µf		50 dcwv	COE-57
MISCELLANEOUS				
J601	Connector, Coaxial			874-4501
LC601	Filter			1114-41-6
Q601	Transistor			2N1374
Q602	Transistor			2N1374
Q603	Transistor			2N1374

For notes, see page 21.



Schematic Diagram, Type 1114-P6 400-CPS Plug-In Unit

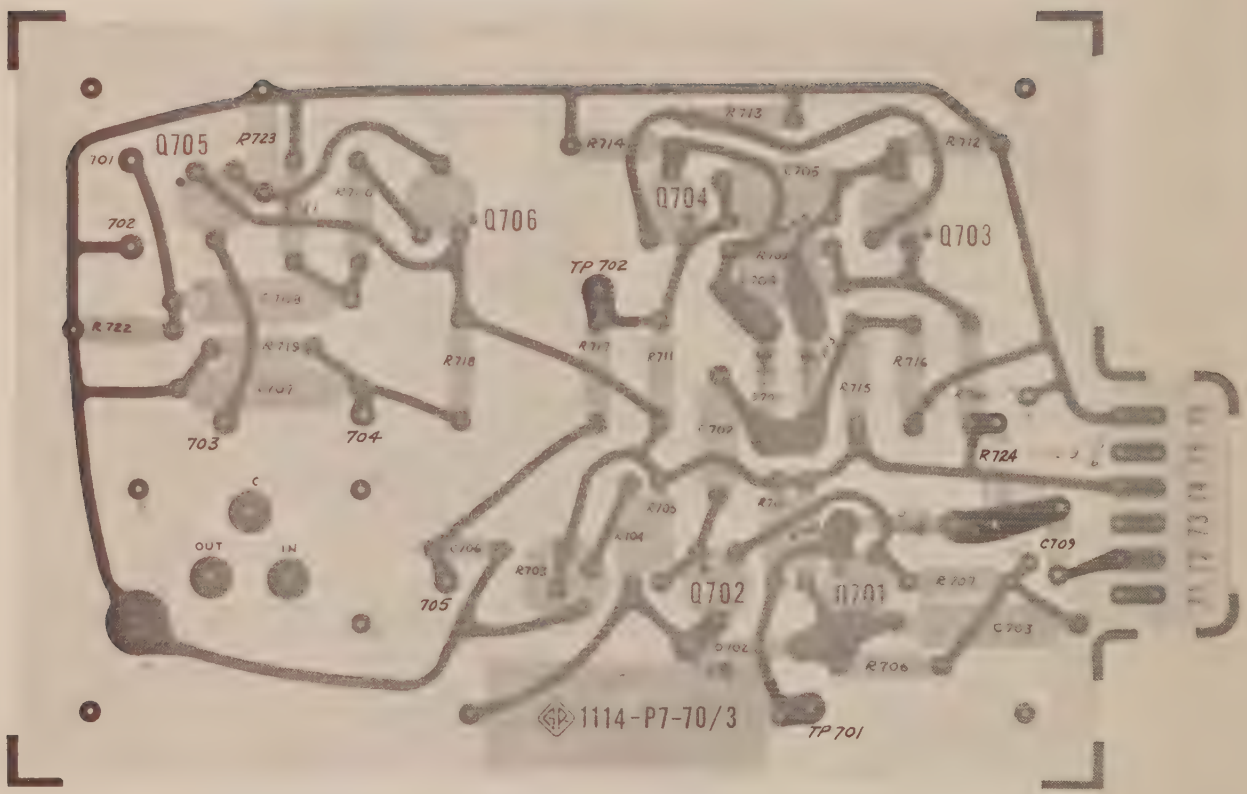


Figure 30a. Etched Board Layout, Type 1114-P7 60-CPS Plug-In Unit.

PARTS LIST

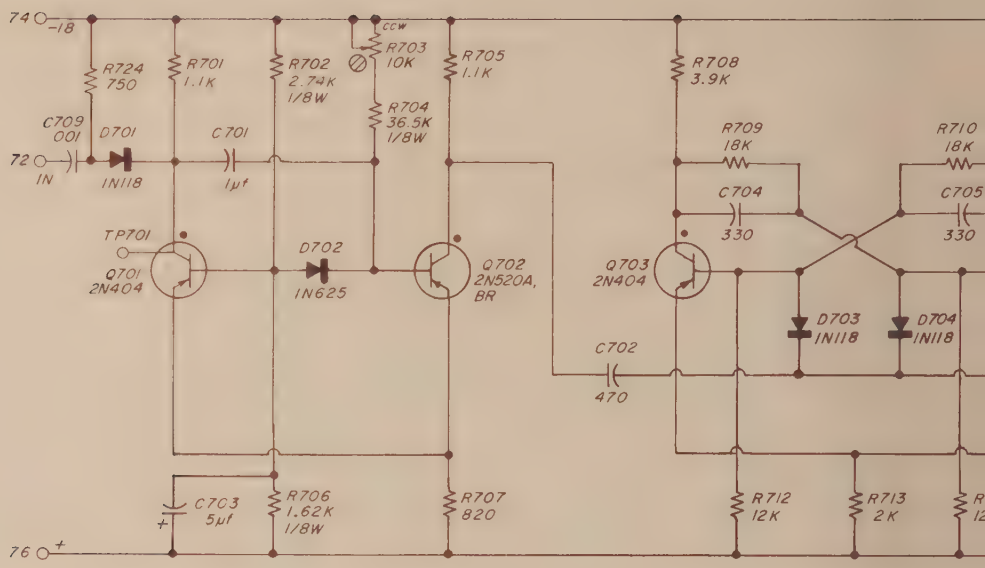
TYPE 1114-P7 60-CPS PLUG-IN UNIT

RESISTORS				PART NO. (NOTE A)
R701	1.1 k	±5%	1/2 w	REC-20BF(112B)
R702	2.74 k	±1%	1/8 w	REF-60(2741A)
R703	10 k	±20%		POSC-22(103)
R704	36.5 k	±1%	1/8 w	REF-60(3652A)
R705	1.1 k	±5%	1/2 w	REC-20BF(112B)
R706	1.62 k	±1%	1/8 w	REF-60(1621A)
R707	820	±5%	1/2 w	REC-20BF(821B)
R708	3.9 k	±5%	1/2 w	REC-20BF(392B)
R709	18 k	±5%	1/2 w	REC-20BF(183B)
R710	18 k	±5%	1/2 w	REC-20BF(183B)
R711	3.9 k	±5%	1/2 w	REC-20BF(392B)
R712	12 k	±5%	1/2 w	REC-20BF(123B)
R713	2 k	±5%	1/2 w	REC-20BF(202B)
R714	12 k	±5%	1/2 w	REC-20BF(123B)
R715	10 k	±5%	1/2 w	REC-20BF(103B)
R716	6.2 k	±5%	1/2 w	REC-20BF(622B)
R717	1.5 k	±5%	1/2 w	REC-20BF(152B)
R718	10 k	±5%	1/2 w	REC-20BF(103B)
R719	10 k	±5%	1/2 w	REC-20BF(103B)
R720	470	±5%	1/2 w	REC-20BF(471B)
R721	1 k	±5%	1/2 w	REC-20BF(102B)
R722	33 k	±5%	1/2 w	REC-20BF(333B)
R723	15 k	±5%	1/2 w	REC-20BF(153B)
R724	750	±5%	1/2 w	REC-20BF(751B)

CAPACITORS				PART NO. (NOTE A)
C701	1 µf	±2%	100 dcwv	COP-24(105A1)
C702	470 pf	±10%NM	500 dcwv	COC-21(471C)
C703	5 µf		50 dcwv	COE-57
C704	330 pf	±10%NM	500 dcwv	COC-21(331C)
C705	330 pf	±10%NM	500 dcwv	COC-21(331C)
C706	0.001 µf	±20%	500 dcwv	COC-60(102D)
C707	5 µf		50 dcwv	COE-57
C708	10 µf		25 dcwv	COE-56
C709	0.001 µf	±20%	500 dcwv	COC-60(102D)

MISCELLANEOUS		
D701	Diode	1N118
D702	Diode	1N625
D703	Diode	1N118
D704	Diode	1N118
J701	Connector, Coaxial	874-4501
LC701	Filter	1114-41-7
Q701	Transistor	2N404
Q702	Transistor	2N520A,BR
Q703	Transistor	2N404
Q704	Transistor	2N404
Q705	Transistor	2N1374
Q706	Transistor	2N1374

For notes, see page 21.

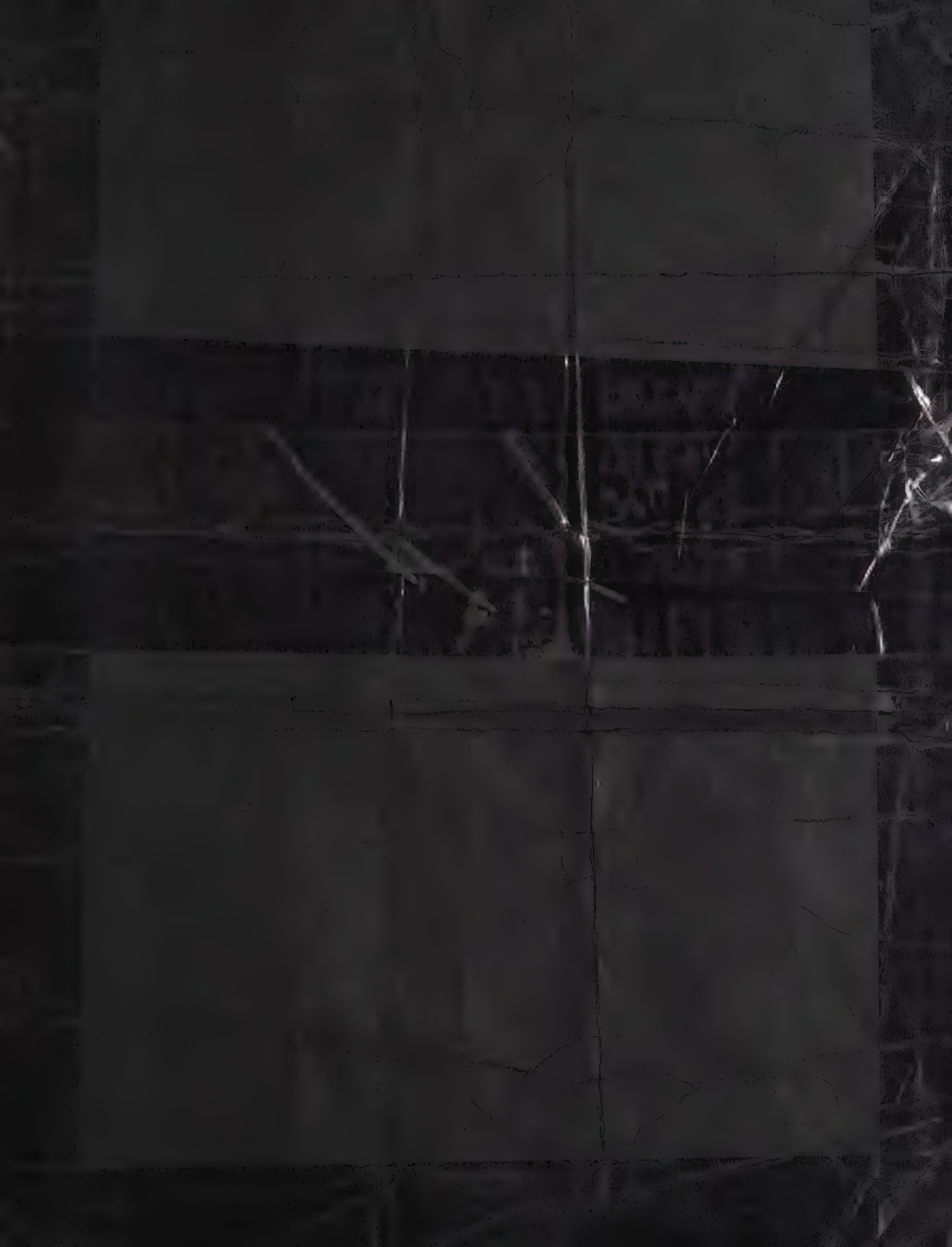


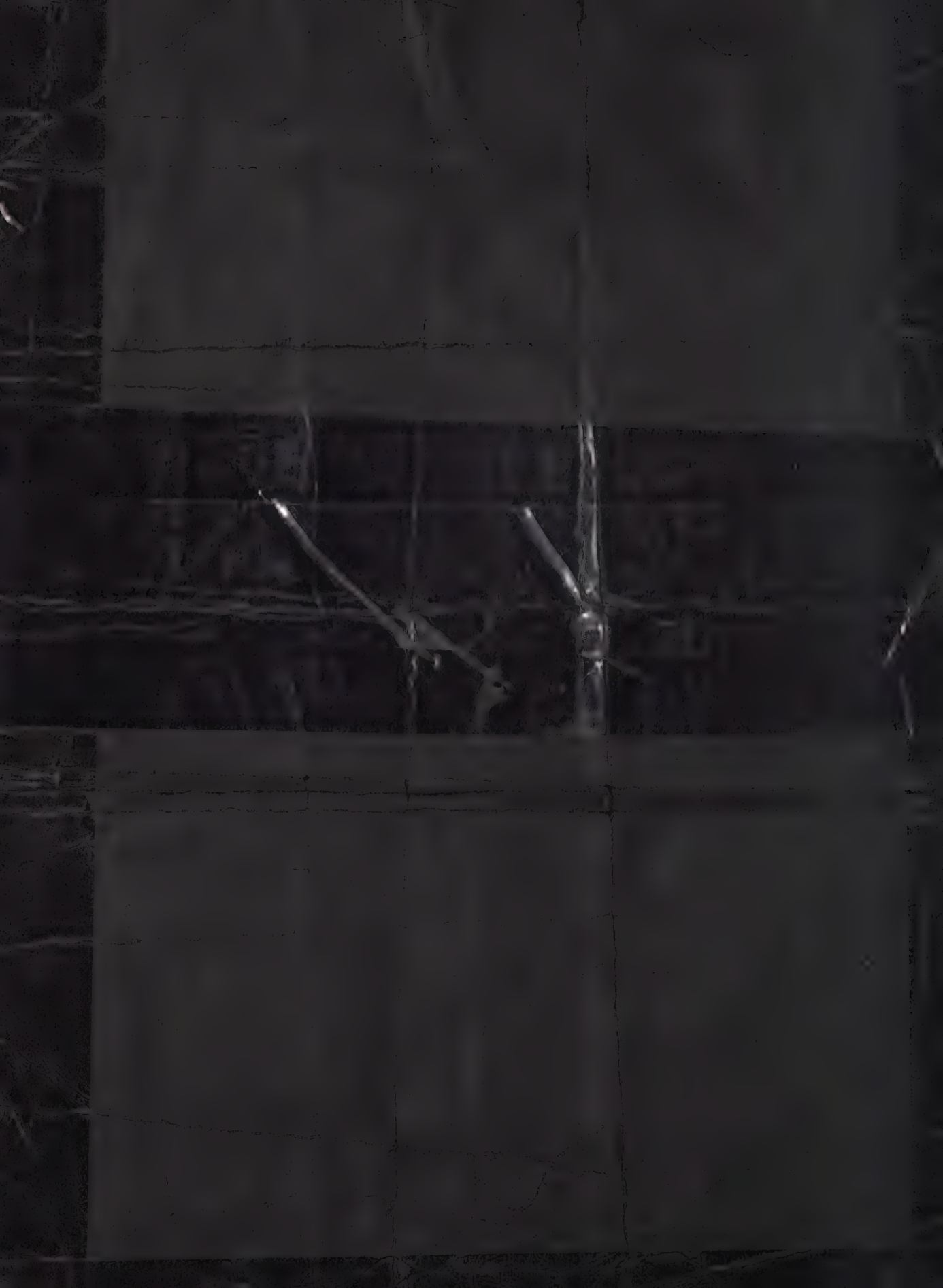
NOTE:
RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K = 1000 M = 1 MEGOHM
CAPACITANCE VALUES ONE & OVER IN MICRO-MICRO-FARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
⊘ SCREWDRIVER CONTROL
ANCHOR TERMINALS USED: 701, 702, 703, 704, 705

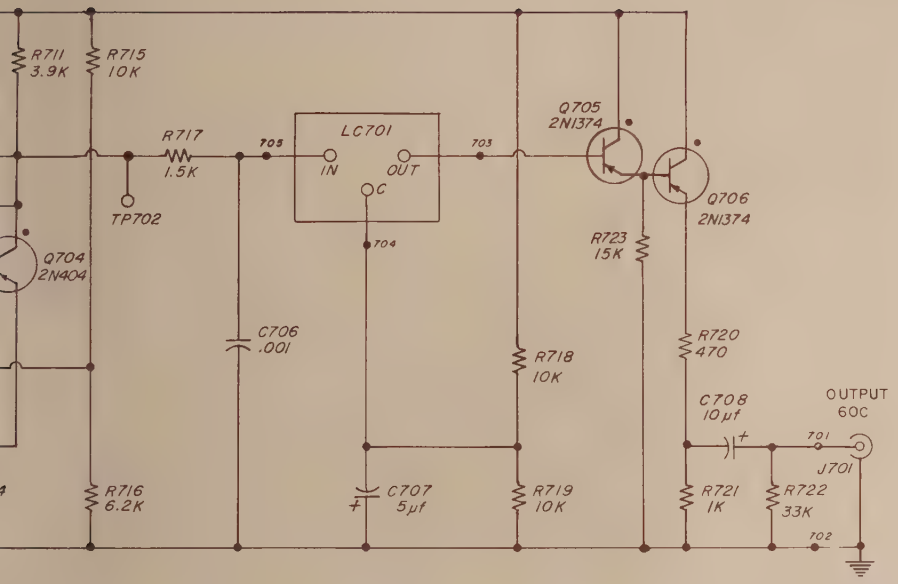
Figure 30. Schematic Diagram, Type

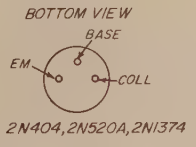
Block Diagram

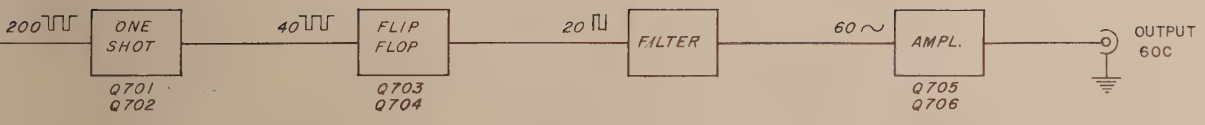
INPUT






R711
3.9K
R715
10K
R717
1.5K
705
LC701
IN
OUT
C
703
704
TP702
Q704
2N404
Q705
2N1374
Q706
2N1374
R723
15K
C706
.001
R718
10K
R720
470
C708
10µf
OUTPUT
60C
701
J701
R716
6.2K
C707
5µf
R719
10K
R721
1K
R722
33K
702


BOTTOM VIEW
BASE
EM
COLL
2N404, 2N520A, 2N1374


200
ONE SHOT
Q701
Q702
40
FLIP FLOP
Q703
Q704
20
FILTER
60 ~
AMPL.
Q705
Q706
OUTPUT
60C

PARTS LIST
TYPE 1114-A FREQUENCY DIVIDER

RESISTORS (NOTES A, C)

R801	10k	± 1%	1/8 w	REF-60(103A)
R802	2.5k	±20%		POSC-22(252D)
R803	9.09k	± 1%	1/8 w	REF-60(9091A)
R804	8.2k	± 5%	1/2 w	REC-20BF(822B)
R805	10k	± 5%	1/2 w	REC-20BF(103B)
R806	10k	± 5%	1/2 w	REC-20BF(103B)
R807	1.2k	± 5%	1/2 w	REC-20BF(122B)
R808	2.7k	± 5%	1/2 w	REC-20BF(272B)
R809	1.5k	± 5%	1/2 w	REC-20BF(152B)
R810	330	± 5%	1/2 w	REC-20BF(331B)
R811	1.2k	± 5%	1/2 w	REC-20BF(122B)
R812	2.4k	± 5%	1/2 w	REC-20BF(242B)
R813	330	± 5%	1/2 w	REC-20BF(331B)
R901	1 k	± 5%	1/2 w	REC-20BF(102B)
R902	680	± 5%	1/2 w	REC-20BF(681B)
R903	5.1k	± 5%	1/2 w	REC-20BF(512B)
R904	1.2k	± 5%	1/2 w	REC-20BF(122B)
R905	4.7k	± 5%	1/2 w	REC-20BF(472B)
R906	2.5k	±20%		POSC-22(252D)
R907	2.2k	± 5%	1/2 w	REC-20BF(222B)
R908	4.7k	± 5%	1/2 w	REC-20BF(472B)
R909	390	± 5%	1/2 w	REC-20BF(391B)
R910	1.2k	± 5%	1/2 w	REC-20BF(122B)
R911	620	± 5%	1/2 w	REC-20BF(621B)
R912	390	± 5%	1/2 w	REC-20BF(391B)
R913	3.6k	± 5%	1/2 w	REC-20BF(362B)
R914	56	± 5%	1/2 w	REC-20BF(560B)

CAPACITORS (NOTES B,C)

C801	100	25 dcwv	COE-35
C802	5	50 dcwv	COE-57
C803	300	15 dcwv	COE-36
	300	15 dcwv	

CAPACITORS (NOTES B,C)

C804	300		15 dcwv	COE-36
	300		15 dcwv	
C805	300		15 dcwv	COE-36
	300		15 dcwv	
C806	300		15 dcwv	COE-36
	300		15 dcwv	
C901	0.01	+80-20%	50 dcwv	COC-61-3(103)
C902	0.01	+80-20%	50 dcwv	COC-61-3(103)
C903	470 pf	±20%	500 dcwv	COC-60(471D)
C904	0.001	±20%	500 dcwv	COC-60(102D)

FUSES

F801	(115 v) 1/10 amp Slo-Blo	FUF-1
	(230 v) 1/16 amp Slo-Blo	FUF-1
F802	(115 v) 1/10 amp Slo-Blo	FUF-1
	(230 v) 1/16 amp Slo-Blo	FUF-1

MISCELLANEOUS

D801	DIODE	SV129
D802	DIODE	1N966
L901	CHOKE, 470 µh ±10%	CHM-6(471 C)
L902	CHOKE, 12 µh ±10%	CHM-1(120D)
L903	CHOKE, 8.2 µh ±10%	CHM-1(082D)
P801	LAMP, 6.3v Mazda 44	2LAP-939
RX801	RECTIFIER	1N1692
RX802	RECTIFIER	1N1692
S801	SWITCH	SWRW-209
T801	TRANSFORMER	745-420

TRANSISTORS

Q801	2N169A	Q804	2N1374	Q901	2N582
Q802	2N169A	Q805	2N1374	Q902	2N582
Q803	2N1374	Q806	2N1218	Q903	2N582

NOTES

(A) All resistances are in ohms except as otherwise indicated.

(B) All capacitances are in µf except as otherwise indicated.

(C) Type designations for resistors and capacitors are as follows:
- COC-Capacitor, ceramic
- COE-Capacitor, electrolytic
- POSC-Potentiometer, composition
- REC-Resistor, composition
- REF-Resistor, film

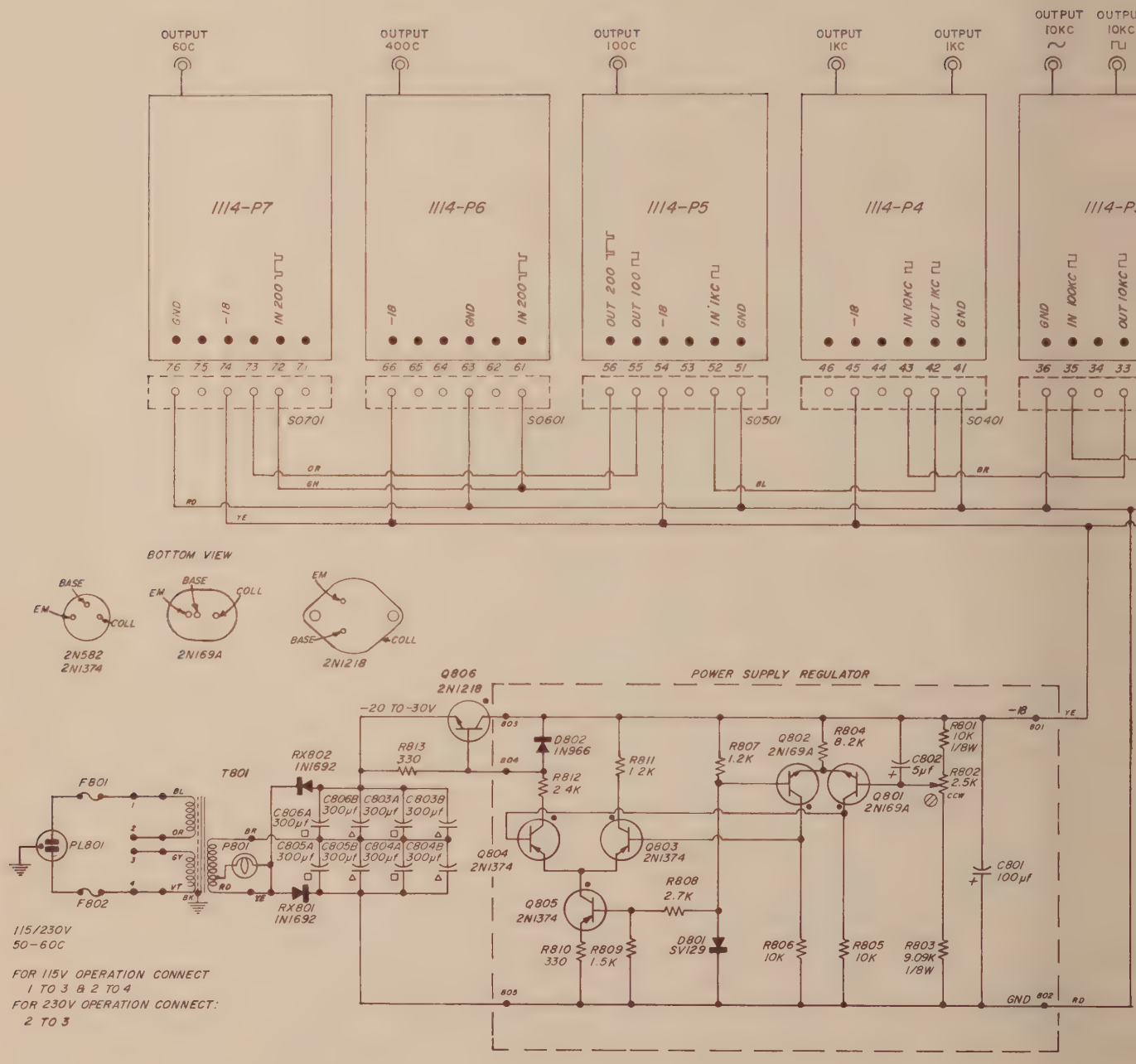
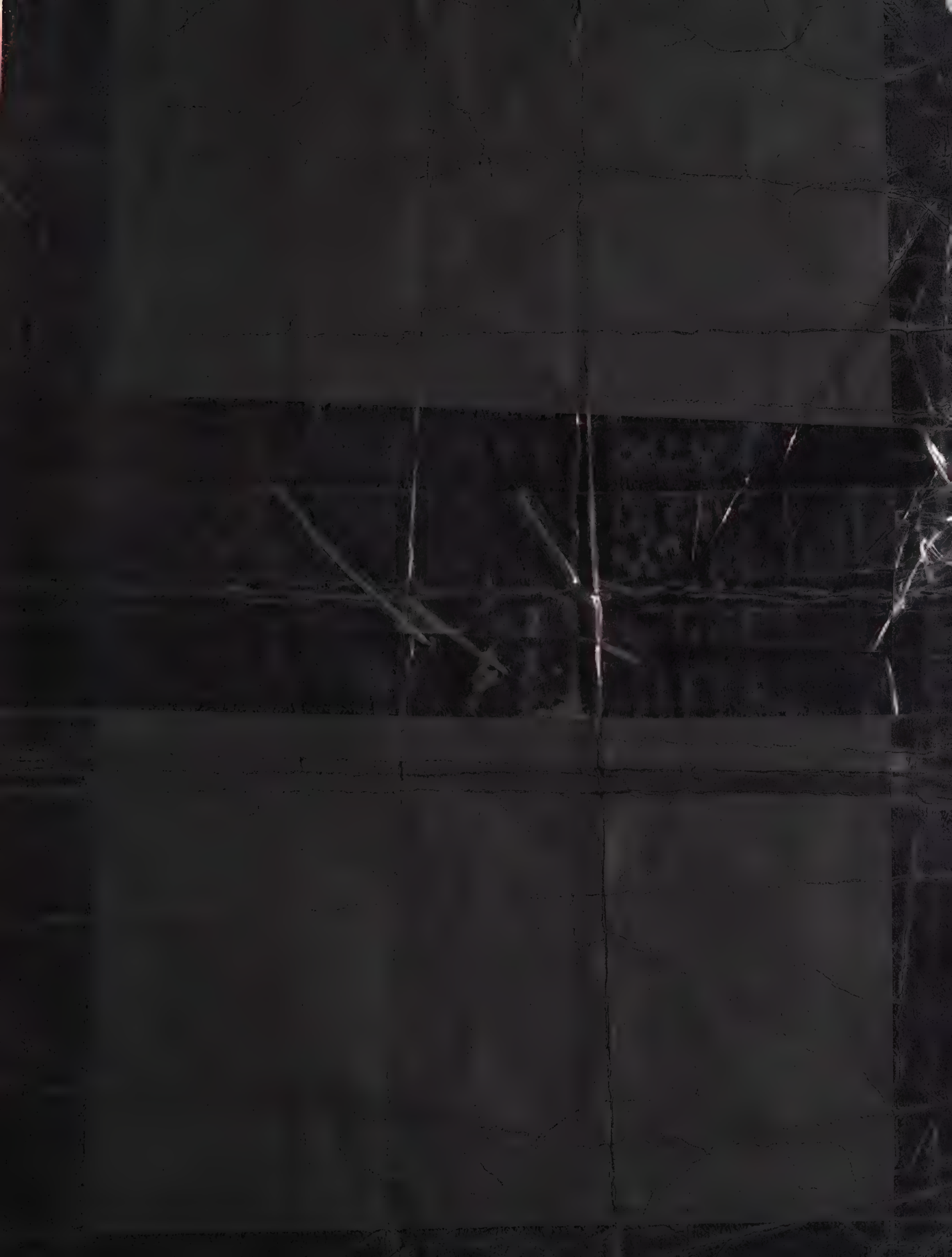
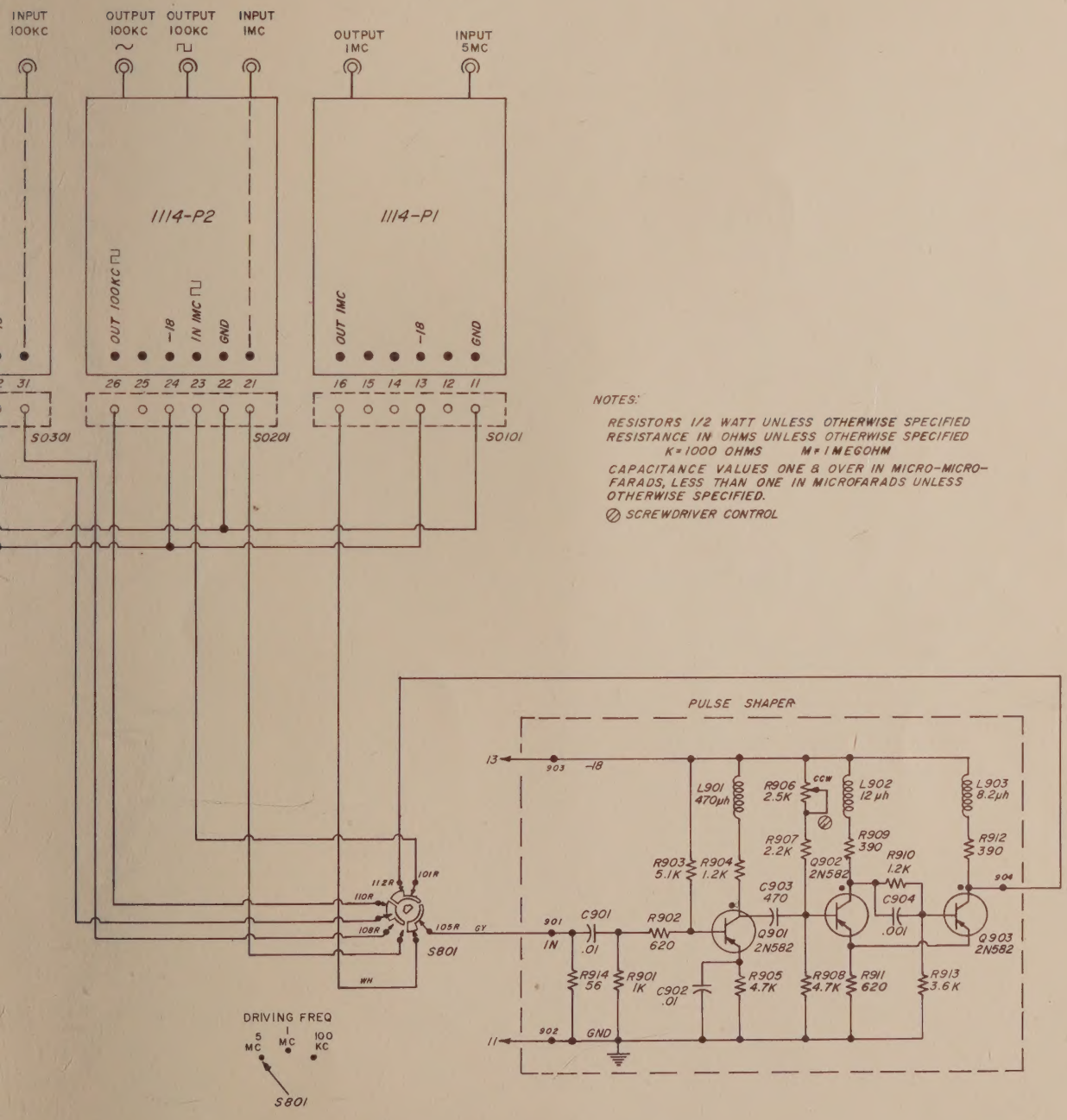


Figure 31. Schematic Diagram for





Type 1114-A Frequency Divider.

GENERAL RADIO COMPANY

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General Radio Company
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